Decentralised water and waste treatment in view of resource recovery

Stijn W.H. Van Hulle[1]

[1]LIWET, Department of Green Chemistry and Technology, Ghent University Campus Kortrijk, B-8500 Kortrijk, Belgium
Presenting author email: stijn.vanhulle@ugent.be

In many parts of the world, including Flanders and the Netherlands, there will be many challenges in the coming years to build and/or upgrade water and waste treatment plants. Centralized systems can be used in case of high population density, but the continued growth and the lack of water treatment systems in peripheral zones increases the demand for use of decentralized systems. As this involves large investments, it is necessary to investigate which new, innovative and energy efficient systems can offer a sustainable solution that incorporate e.g. reuse of (rain)water and nutrients. The application of decentralised systems offers the benefit that transport of water, energy and nutrients is largely reduced (Libralato et al., 2012).

In order to demonstrate the potential of different techniques that can be used for decentralised treatment several pilot test are being conducted. Efficient water treatment for discharge, potable water production from secondary effluent and nutrient and energy recovery are demonstrated.

A first case study consists of operating a temporary and mobile waste water treatment system at (music) festivals. Such multi-day events lay a heavy burden on the surrounding environment, especially in terms of (waste) water (Van Hulle et al., 2008). As such, efficient water treatment is necessary. The system that was operated consists of a typical vertical flow wetland suited in a 15 m³ container. This container is filled with a gravel bed with plants on top. The grey water that needs treatment percolates through the filter material and is finally collected by a drainage network at the base of the container. The mobile system was operated at different music festivals during the 2017 and 2018 summer festival season. The obtained results indicate toward a good removal of COD, BOD, suspended solids and detergents. Discharge limits for BOD and suspended solids (the only parameters regulated for decentralised waste water systems in Flanders) were met. Through nitrification in the system, also ammonium is removed, but no full denitrification was obtained (as such, nitrate remains in the effluent). No phosphate removal was obtained. In Figure 1 the removal of different parameters is demonstrated (76 m³ was treated in total). In the future (2019 edition) coupling with an off-grid drinking water production system is foreseen.

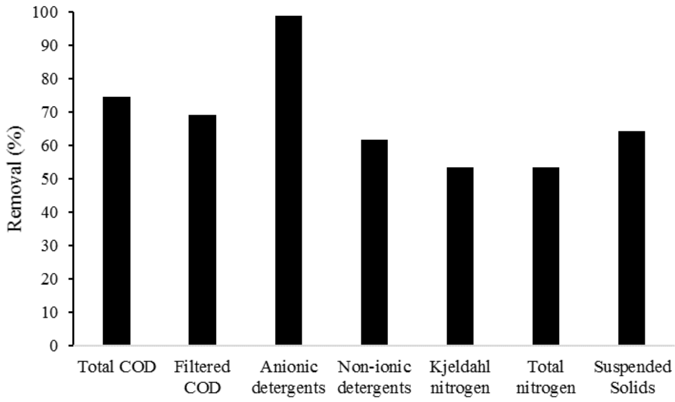

Figure 1. Removal of different parameters by the mobile constructed wetland at the 2018 edition of the Dranouter Music Festival

In a second case study, phosphate and nitrogen removal from goat milk company waste water effluent through low cost natural and commercial substrates (zeolite, volcanic rock, bark chips, iron oxides coated granules (IOCG), iron oxides coated granules with sand as core material (IOCG+S), granular activated carbon (GAC), anion exchange resin (AEIX) and sea shells) was investigated. The wastewater in this case was already treated by a constructed wetland with lava rock substrate, but nutrient (especially phosphate) removal was insufficient to meet discharge limits. A column-adsorption system was built and tested with the various substrates to evaluate the adsorption capacity at equivalent hydraulic loading rate. The results indicate that for phosphate removal, IOCG, IOCG+S, GAC and AIEX performed very well with 98-100% removal. The removal capacity for total nitrogen followed the order: AIEX > zeolite >GAC> wood chips> volcanic rock > IOCG+S> IOCS > sea shells.

The adsorption into these materials has been further studied using batch-adsorption tests. The results of the initial batch adsorption experiments showed that IOCS and IOCG+S are both performing very well in removing phosphate. Remarkable about these substrates is that they are waste materials themselves, originating from the iron removal step during drinking water treatment (Vandermoere et al., 2018). As such waste material is used as resource for water treatment. In Figure 2 the total phosphorous removal of several substrates is demonstrated.

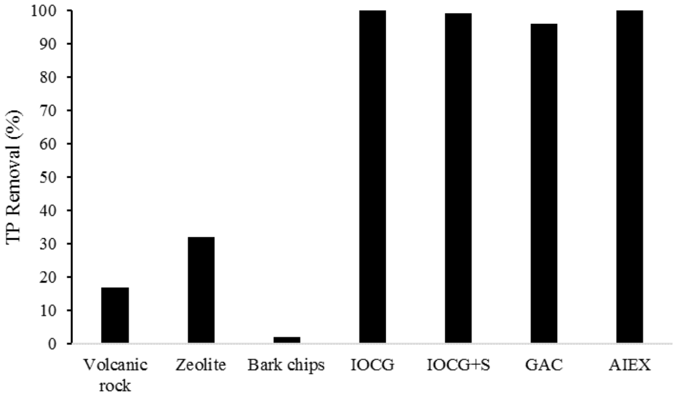

Figure 2. Total phosphorous removal of different substrates when treating goat milk company waste water effluent with low cost natural and commercial substrates

A third case study deals with the separate treatment of grey, yellow and black water originating from an outdoor sports center in view of maximal recuperation. In total, about 350 litre per week of yellow water can be collected. This yellow water is ozonated for stabilisation and disinfection prior to application as fertiliser. The black water (+/- 17 m^3 per week) will be treated in an MBR system, while the grey water (+/- 38 m^3 per week)) will be treated in a new type of aerated constructed wetland (with activated carbon and expanded clay as substrate), incorporated in the parking lot (www.rietland.com).
A fourth case study deals with restaurant waste water treatment and re-use. A restaurant located in an area were no drinking water distribution and no sewer system is present (which is rather rare in Flanders) will be equipped with a 50 m^2 constructed wetland treating 3,5 m^3 per day of waste water. This water will be treated further by a BOSAQ membrane filtration system (www.bosaq.com), producing about 2,4 m^3 per day of potable water by membrane (UF-RO) filtration for the restaurant visitors. This amount is sufficient to supply all the potable water necessary for the restaurant (cooking, drinking, toilet flushing, …).

References

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