Environmental assessment of alternative treatments for wastewater and domestic organic waste

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Abstract
The environmental comparison of two alternative scenarios for the co-treatment of wastewater and domestic organic waste was performed. Both schemes include the anaerobic treatment of wastewater. However, they differ in the treatment of the effluent; one includes the removal of nutrients whereas the other an anaerobic membrane. The first scheme achieved better results in eutrophication related categories compared with the second one; however, the results were worse in energy related categories due to energy requirements in aeration.

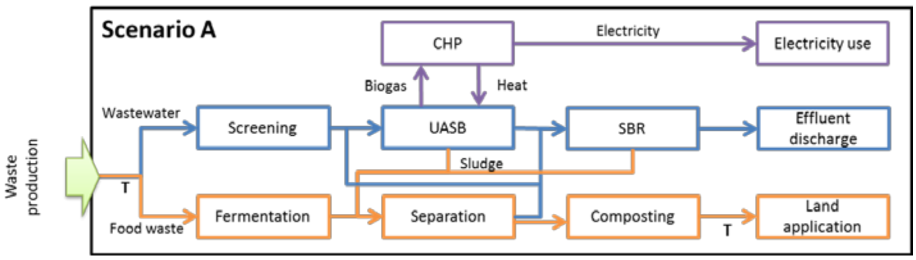
Keywords
decentralised system; environmental profile; municipal wastewater; food waste

INTRODUCTION

Upflow anaerobic sludge blanket (UASB) reactors are an available technology for the treatment of municipal wastewater (Nair and Ahammed, 2014). Comparing to aerobic systems, they require lower energy requirements, low sludge production and the co-production of biogas. However, the resulting effluent needs an additional post-treatment for the biological removal of nutrients (Malamis et al., 2013), especially mandatory for the discharge in sensitive water courses. The anaerobic membrane bioreactor (AnMBR) is also another available option (Ozgun et al., 2013). The process is energy efficient and minimises sludge production. The objective of this study was to assess and compare, from a Life Cycle Assessment (LCA) perspective, the environmental performance of two alternative scenarios for the decentralised co-treatment of wastewater and domestic organic waste (DOW).

MATERIALS AND METHODS

Both scenarios manage the wastewater and DOW generated by a small community of 2,000 population equivalent. Regardless the scenario, wastewater is treated in a UASB, DOW is fermented and the produced sludge is composed. Concerning the effluent post-treatment from the UASB, Scenario A includes the removal of nutrients in a Sequencing Batch Reactor (SBR) via nitrification/denitrification, while Scenario B uses a membrane for the removal of solids. The treatment system proposed is outlined in **Figure 1.**



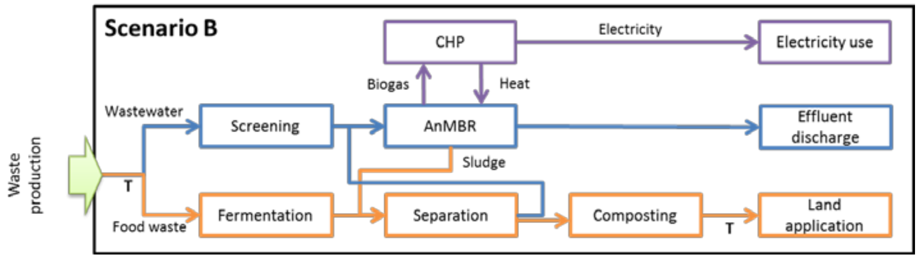


Figure 1. Flowchart of the treatment schemes proposed for assessment

RESULTS AND CONCLUSIONS

In this study, characterisation factors supplied by the ReCiPe Midpoint (H) method (Goedkoop et al., 2009) have been considered for the following impact categories: Climate Change (CC), Terrestrial Acidification (TA), Freshwater Eutrophication (FE), Marine Eutrophication (ME), Photochemical Oxidant Formation and Fossil Depletion (FD) (Goedkoop et al., 2009). The comparative results between both scenarios are shown in **Figure 2**.

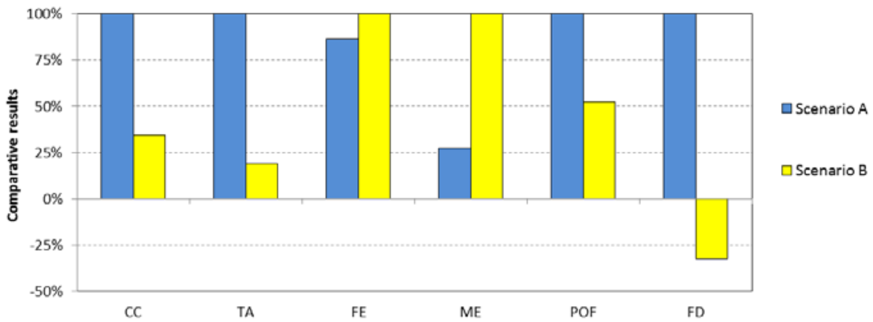


Figure 2. Comparative results for Scenarios A and B

Scenario B exhibits the best environmental performance concerning CC, TA, POF and FD. It generates more biogas thanks to the recirculation of the fermented DOW to the reactor. However, it is more energy-intensive due to the SBR. However, the quality of the effluent in terms of nutrients is better in Scenario A than in B, with better results in FE and ME categories. Due to the variation of results depending on the impact category, normalisation step has been performed. In this case, Scenario A obtained a normalisation score of 11.3, whereas it is 15.3 in Scenario B. Therefore, Scenario A, despite of its energy consumption, would be a better option compared with Scenario B. However, the treatment configuration applied would depend, in any case, on the specific conditions of the discharge area. The application of the system with the AnMBR could be only applied where nutrients removal is not required. When N and P removal is required, the configuration with the SBR would still be the most suitable.

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