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Evaluation of Different Substrates in Constructed Wetlands Planted with *Typha latifolia* for the Treatment of Tannery Wastewater

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INTRODUCTION

The wastewater originated from the tannery industry is a major environmental problem, due to its complex composition, with high organic and inorganic contents. An integrated water management is crucial for the sustainable development of the sector, as industrial plants have high water consumption. Constructed wetlands (CW) may be a feasible approach for the treatment of tannery wastewater (Daniels, 2001; Kucuk et al., 2003; Calheiros et al, 2007).

The aim of this study was to investigate the performance of three horizontal subsurface flow CWs with different substrates – two types of expanded clay and fine gravel, planted with *Typha latifolia,* for the treatment of tannery industrial wastewater. Relations between filter media, plant development and treatment efficiency were assessed.

METHODS

Three parallel constructed wetland pilot units (CWU) were established with *T. latifolia* in different substrates. The following aggregates were used: fine gravel (FG) – AGH 4–8 mm, with particle size ranging from 4 to 8 mm (Areipor – Areias Portuguesas, Lda – Portugal); Filtralite® MR 3–8 (FMR) and Filtralite® NR 3–8 (FNR), with particle size ranging from 3 to 8 mm (maxit - Argilas Expandidas, SA – Portugal). Another pilot unit was established with FMR but was kept without plants. The substrates used in the experiments were analyzed for pH, specific electrical conductivity (EC), organic matter content (OM) and porosity. The structure of the units was made of propylene with the following design characteristics: surface area of the bed, $A = 1.2\ m^2$, effective depth of the media, $h = 0.60$ m, and average depth of liquid in the bed, $ho = 0.55$ m. Feeding of wastewater to the pilot units was made through a perforated polyvinylchloride (PVC) rigid pipe with flow control.

The systems operated for two and half years under different hydraulic conditions – 18, 8.4 and 6 cm d^{-1}. Samples were periodically taken at the inlet and outlet of the CWUs. The following parameters were determined, based on Standard Methods for the Examination of Water and Wastewater: pH, electrical conductivity (EC), chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), total suspended solids (TSS), Kjeldahl nitrogen (TKN), nitrate (NO_3^-), ammonia (NH_3), total phosphorus (total P) and total chromium (total Cr). The sulphates determination (SO_4^{2-}) was based on the Association of Official Analytical Chemists. The plant material was monitored in terms of propagation and development and was analyzed for chlorophyll *a+b* content in leaves and peroxidase activity (POD) in roots.

RESULTS

The removal of COD, BOD_5 and TSS was proportional to the influent load, as indicated by the linear relationship between Mass removal and Mass loading. In Table 1 the minimum and maximum mass removal values for each unit are shown.

Nutrient, sulfates and nitrogen removal occurred to lower extents. Total chromium was only detected at low concentrations at the inflow and outflow of the units.

Table 1. Organic loading and mass removal (COD and BOD based) for each pilot unit. Minimum and maximum values are shown.

Parameter	HLR (cm d^{-1})	Organic loading (kg ha^{-1} d^{-1})	Mass removal (kg ha^{-1} d^{-1})			
			U1[a]	U2[a]	U3[a]	U4[a]
COD	18	2437–3849	975–1599	1084–1869	835–1203	727–1293
	8.4	1471–1764	696–1094	727–979	576–930	493–832
	6	485–1469	174–603	229–1131	185–873	147–736
BOD	18	1296–1800	335–612	378–652	288–540	259–432
	8.4	521–722	202–361	224–344	160–302	146–260
	6	216–516	72–282	90–300	48–234	36–222

[a] Unit 1: FNR, Unit 2:FMR, Unit 3: FG, Unit 4: control FMR

The systems were capable to tolerate inflow fluctuations and interruptions in the feed of wastewater during shutdown periods (up to two months).

Plant development and propagation were more successful in the substrates FMR and FNR. In contrast, with the substrate FG the plants did not grow so successfully, which may explain the lower efficiency of this unit when compared to those established with the expanded clay material.

Concerning the POD activity of the plant roots, no significant differences were found within the same unit – from plants collected at the inlet and outlet of each unit, nor within different planted units. As to the chlorophyll *a+b* content in leaves from plants collected from the inlet and outlet of each unit, again no significant differences were found. The same occurred between units.

CONCLUSIONS

The findings from this study show that CWs containing the Filtralite substrate with plants led to higher organic (COD) load removal when compared to the control unit, indicating that vegetation may benefit the microbial activity occurring within the systems. Concerning the fine gravel unit, the removal was significantly lower when compared to the FMR and FNR units. The mass removal (COD) was significantly different at each of the three HLRs applied. These systems are a viable alternative for reducing the organic matter content of wastewaters. The application of CWs to the treatment of tannery effluents may be an attractive approach for integrated secondary treatment, although larger scale experiments should be undertaken.

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REFERENCES

Calheiros, C.S.C., Rangel, A.O.S.S. and Castro, P.M.L. (2007) Constructed wetland systems vegetated with different plants applied to the treatment of tannery wastewater. *Water Res.* 41(8): 1790–1798

Daniels, R. (2001) Enter the root-zone: green technology for the leather manufacturer. Part 3. *World Leather* 14 (6): 85–88.

Kucuk, O.S., Sengul, F. and Kapdan, I.K. (2003) Removal of ammonia from tannery effluents in a reed bed constructed wetland. *Water Sci. Technol.* 48(11–12): 179–186.