5th EuGSC

European Conference on Green and Sustainable Chemistry

5th

EuChemS Conference on Green and Sustainable Chemistry

Conference Proceedings

26-29 September 2021

Virtual Conference

www.5eugsc.org

co-Organized by

EuChemS

European Chemical Society

Division of Green and Sustainable

Performance evaluation of vertical constructed wetlands for the treatment of oily industrial wastewater

Ghezali K.[1]* and Bentahar N.[1]
[1]University Mhamed Bougara of Boumerdes, Avenue of independence 35000 Boumerdes, Algeria
*e-mail address of corresponding author: k.ghezali@univ-boumerdes.dz

Abstract text:
Industrial wastewater treatment is important study area in environmental engineering. The treatment of petroleum and petrochemical wastewater is widely studies area of research. These streams are difficult to treat due to large concentrations of oil [1]. The wastewater from Petroleum industries and refineries mainly contains oil, organic matter and other compounds such as heavy metals [2]. Constructed wetland treatment systems (CWs) are a potential treatment method that can effectively remove many constituents of industrial wastewater [3]–[5], and offer low-energy, and less-operational-requirements alternative to conventional treatment systems [6]. CWs have been utilized to treat a variety of waters including wastewater originating from farming practices, acid mine drainage, petroleum refinery effluents, flue gas desulfurization wastewater, brackish oilfield produced water, and other industrial effluents [7], [8]. Plant species and media types are crucial influencing factors to the removal performance in CWs as they are considered to be the main biological component of CWs [9].
The interaction between the soil matrix, plants and microbial population brings about many processes responsible for the elimination of contaminants. These include: phytoextraction, phytostabilization, rhizofiltration, phytovolatilization [10], [11]. Previous research [12] showed that pilot-scale CWs can effectively treat O & G and metals in simulated oilfield produced water.
The purpose of this investigation was to evaluate a specifically designed pilot-scale CWs for treating petroleum industry wastewater collected after passing through an oil–water separator located in the industry.

Two lab scale macrosomes of 25 L vertical flow constructed wetlands (VFCW) designed and constructed in a climate-controlled greenhouse located in university of boumerdes (Algeria), were used to assess treatment performance for oily wastewater from petroleum industry. SSF cells were planted with Phragmites australis (common reed), a macrophyte native to Sub-Saharan Africa and found throughout temperate and tropical regions. Layers of 5cm large gravel (d = 2–2.5 cm), 15cm fine gravel (d = 1–1.5 cm), and 15cm of coarse sand were composed in both VFCW as substrate. The pilot-scale system was designed based on biogeochemical pathways to decrease aqueous concentrations of targeted constituents of concern (oil and grease (O & G), Fe, Cd, Pb, Zn). Standard methods were used for the estimation of each parameter [13]. After the proper acclimatization of macrophytes in the wetlands, the treatment of IWW was carried out in batch mode. The batch treatment was carried out to optimize the process parameters. Effluent samples from each CW were collected and analyzed after fixed retention time for specified parameters. The samples for analysis were taken from influent of VFCW, at the outlet of VFCW. The removal efficiency of each parameter was calculated using the Eq. (1) as follows:

$$R.E = \left(\frac{C_{in} - C_{out}}{C_{in}}\right) \times 100\% \quad (1)$$

where: R.E: Removal Efficiency, %; C_{in}: Inflow Concentration, $mg \cdot L^{-1}$; C_{out}: Outflow Concentration, $mg \cdot L^{-1}$

The mean removal efficiencies of heavy metals from the industrial wastewater stream based on influent and effluent concentrations (using Equation (1)) are presented in Table 1. The P. australis planted VF-CW showed a metal removal performance in the order of Cd>Fe>Pb>Zn. The P. australis vertical subsurface flow constructed wetlands had the highest (96%) performance for Cd removal, and the least removed metal was Zn (61%).

Table 1. Influent, effluent and R.E of heavy metals in the VCWs investigated

Parameters	Influent conc. ($mg \cdot L^{-1}$)	effluent conc. ($mg \cdot L^{-1}$)	Removal efficiency (%)
Pb	0.16	0.05	68.75
Cd	0.23	0.01	95.65
Zn	0.028	0.011	60.71
Fe	0.7	0.08	88.57

Figure 1 presents the oil and grease concentrations in the influent and effluent from the VF CWs. The influent had concentrations that varied between 50.15 to 70.78 mg/L, the effluent concentrations ranged between 10.28 to 18.92 mg/L. The P. australis VF CW had a mean removal efficiency ranging from 72 to 79%.

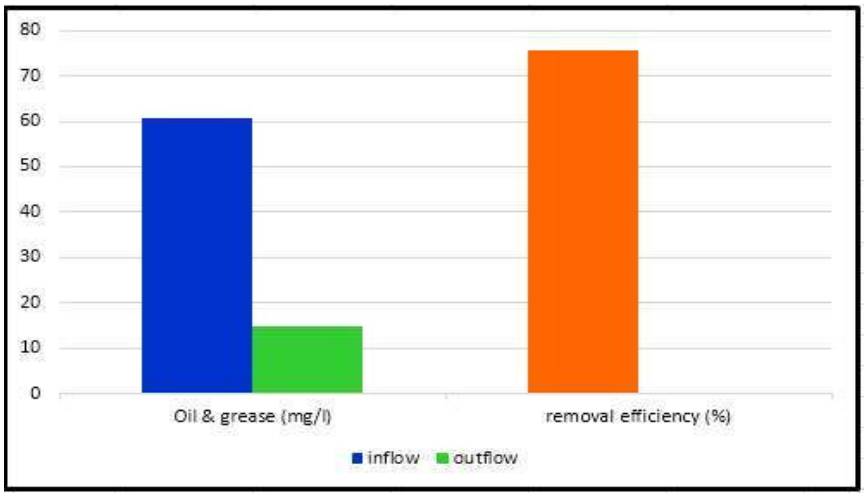

Figure 1. Influent and effluent concentrations and removal efficiency by P. australis VF CW.

This study showed that the planted VSF-CWs effectively reduced the concentration of all the heavy metals monitored from the petroleum industry wastewater. The heavy metal removal processes were sedimentation and plant uptake. In addition, increasing the HRT, or increasing the size and depth of the VFCWs could also further reduce the concentration of the heavy metals in the effluent [14].

Furthermore, This study showed that VSF CWs planted with P. australis have a high potential to reduce oil and grease from oil refined wastewater (Fig. 1). The removal efficiency of oil and grease achieved 76% for the planted system (phytostimulation or rhizodegradation) suggesting the positive effect of the presence of plants on CWs performance. The results obtained demonstrated that inorganic and organic contaminant concentration was significantly reduced in the effluents. Metal concentration decreased by 69%, 96%, 61%, and 89% for Pb, Cd, Zn and Cu respectively.

References

[1] D. A. D. A. Aljuboury, P. Palaniandy, A. A. H. B, and S. Feroz, "Treatment of petroleum wastewater by conventional and new technologies - A review," *Glob. NEST J.*, vol. 19, no. 3, pp. 439–452, 2017.

[2] A. F .Benyahia, A. Embaby, and M.Rao, "Refinery wastewater treatment : a true technological challenge," *Seventh Annu. U.A.E. Univ. Res. Conf.*, p. 8, 2006.

[3] A. K. Kivaisi, "The potential for constructed wetlands for wastewaer treatment and reuse in developing countries : a review," vol. 16, pp. 545–560, 2001.

[4] S. A. A. A. N. Almuktar, S. N. Abed, and M. Scholz, "Wetlands for wastewater treatment and subsequent recycling of treated effluent: a review," *Environ. Sci. Pollut. Res.*, vol. 25, no. 24, pp. 23595–23623, 2018.

[5] C. S. C. Calheiros, A. O. S. S. Rangel, and P. M. L. Castro, "Treatment of industrial wastewater with two-stage constructed wetlands planted with Typha latifolia and Phragmites australis," *Bioresour. Technol.*, vol. 100, no. 13, pp. 3205–3213, 2009.

[6] T. Avellán and P. Gremillion, "Constructed wetlands for resource recovery in developing countries," *Renew. Sustain. Energy Rev.*, vol. 99, pp. 42–57, 2019.

[7] J. Vymazal, "Constructed wetlands for wastewater treatment," *Water*, vol. 2, no. 3, pp. 530–549, 2010.

[8] H. Wu *et al.*, "A review on the sustainability of constructed wetlands for wastewater treatment : Design and operation," *Bioresour. Technol.*, vol. 175, pp. 594–601, 2015.

[9] H. Brix and H. H. Schierup, "The use of aquatic macrophytes in water-pollution control," *Ambio*, vol. 28, no. 2, pp. 100–107, 1989.

[10] A. Al Mahruki, B. Alloway, and H. Patzelt, "The use of reed-bed technology for treating oil-production waters in the Sultanate of Oman," *8th SPE Int. Conf. Heal. Saf. Environ. Oil Gas Explor. Prod. 2006*, vol. 2, pp. 507–512, 2006.

[11] A. B. T. Akhtar, A. Yasar, R. Ali, and R. Irfan, "Phytoremediation Using Aquatic Macrophytes," *Ansari A., Gill S., Gill R., R. Lanza G., Newman L. Phytoremediation. Springer, Cham.*, pp. 1–514, 2017.

[12] M. J. Pardue, J. W. Castle, J. H. Rodgers Jr, and G. M. Huddleston III, "Treatment of oil and grease in produced water by a pilot-scale constructed wetland system using biogeochemical processes," *Chemosphere*, vol. 103, pp. 67–73, 2014

[13] APHA, AWWA, and WPCF, "APHA, Standard Methods for the Examination of Water and Wastewater, American Public Health Association," *Am. Public Heal. Assoc. Washingt.*, 2005.

[14] H. I. Mustapha, J. J. A. Van Bruggen, and P. N. L. Lens, "Fate of heavy metals in vertical subsurface flow constructed wetlands treating secondary treated petroleum refinery wastewater in Kaduna , Nigeria," *Int. J. Phytoremediation*, vol. 6514, no. July, pp. 0–38, 2017.