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NOTE

Removal of Organics from Micro-Polluted Water in Different Subsurface Constructed Wetlands

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Four subsurface constructed wetlands were carried out treating micro-polluted water. Namely, the effluent of wastewater treatment plants in Tangshan area was used as origin influent water for this study. The chemical pollutant indexes of chemical oxygen demand and total organic carbon were analyzed for evaluating the removal efficiency of pollutants from the secondary effluent of wastewater treatment plant. The four subsurface wetlands showed different behaviors for organic removals. Meanwhile, horizontal subsurface wetlands exhibited more remarkable removal effects on chemical organics.

Keywords: Constructed wetland, Chemical organics, Zeolite and limestone, Secondary effluent, Wastewater treatment plant.

Constructed wetlands (CWs) for wastewater treatment have been extensively applied in many fields, including municipal wastewater[1], ground surface polluted water[2], farm dairy wastewater[3], oilfield drainage[4] and eutrophic aquaculture wastewater[5]. The optimized combination of physical, chemical and biological processes in eco-system is applied to wastewater treatment[6]. The method has the effect of water stability, low running costs, operation safe and convenient, *etc*. According to water flow patterns, constructed wetland can be divided into two basic types which include flow constructed wetlands and subsurface flow constructed wetlands[7-9]. Constructed wetlands is an aquatic ecosystem mainly composed of plants, microbes and substrate. With the coordination of these components, the constructed wetlands can work smoothly and achieve optimum purification capability[10-12].

In most instances, the effluent is direct discharge to rivers and it will bring about river pollutions marginally. Thus, the secondary effluent of wastewater treatment plants is necessary to be treated to reduce any possible impacts on rivers. This study focuses on using subsurface flow constructed wetlands for treating micro-polluted water on the variations of chemical organics pollutant concentration under the optimal hydraulic loading rate.

Experimental system: The experiment took place in a laboratory with a controlled environment in Tangshan of P.R. China. The experimental system consisted of two 1 m^2 wetland mesocosms (1.6 m long × 0.6 m large × 0.6 m deep). Gravel, a particle diameter of 15-25 mm, was laid at the bottom of system and the depth was 0.10 m. Zeolite and limestone were laid at the middle layer, respectively. Both of particle diameters were 6-10 mm and and the depth was 0.20 m. The upper beds were consisted of lytag of a depth of 0.15 m and the particle diameter was 3-5 mm. The sieving soils were laid at the uppermost layer and the depth was 0.05 m. Phragmites and reed mace were planted in the soils. In the meanwhile, the interplanting ratio of plants was 1:1. Meanwhile, the zeolite wetland and limestone wetland would be represented by ZW and LW, respectively.

Influent quality: The raw wastewater, secondary effluent of wastewater treatment plants, was collected from wastewater treatment plant in Tangshan. The composition of the influent used in all experiments is shown in Table-1.

TABLE-1
CHARACTERISTICS OF THE WASTEWATER SAMPLE USED IN THE EXPERIMENTS

Parameter	Unit	Concentration
pH	-	6.5-80
Chemical oxygen demand	mgL^{-1}	92-155
Total organic carbon	mgL^{-1}	60.3-85.6

Analytical methods: Parameters such as soluble chemical oxygen demand, total organic carbon and pH were monitored. Samples were collected once every three days when steady state conditions were achieved. In this experiment, intermittent flow was adapted in four systems and they continuously run for two months.

Removal of chemical oxygen demand: As is shown in Fig. 1, when the four wetlands hydraulic loading the same conditions, in the early throughout the trial started, the horizontal flow wetland chemical oxygen demand removal is better than vertical flow wetlands, horizontal flow effluent concentration range of wetlands is 11.4-28.9 mg/L, removal of COD maintained at 76.9-92.2 %; while the vertical flow wetland effluent chemical oxygen demand concentration was maintained at 26.2 mg/L or more, removal range is maintained at 63.8-82 %. Four kinds of wetlands at this time chemical oxygen demand removal order: HZW > HLW > VMZW > VZW. After a period of operation of wetlands, wetland types chemical oxygen demand removal of certain trends are changed. At the end of the experimental phase, a variety of wetlands chemical oxygen demand removal of stabilizing, the four sewage removal of chemical oxygen demand basic maintenance over 66.4 % removal efficiency at a time when the size of the order: HZW > VMZW > HLW > VZW. In summary, in this pilot phase, HZW wetlands exhibited the most obvious removal effect on chemical oxygen demand.

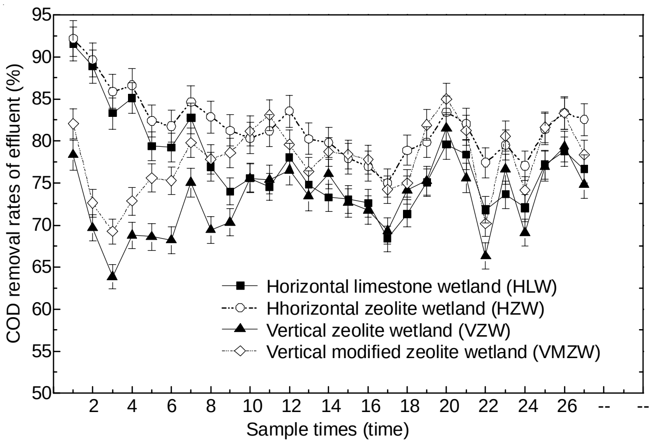

Fig. 1. Removal effect on chemical oxygen demand in every wetland under optimal hydraulic loading

In the early tests of four wetland chemical oxygen demand removal rate is higher, which is likely due to the adsorption filter matrix, which with the passage of time, the adsorption capacity of the matrix close to saturation, the removal efficiency decreased. However, with the test system to gradually adapt to the effluent quality, the removal rate of chemical oxygen demand is stable at a certain level.

Removal of total organic carbon: As is shown in Fig. 2, under the same hydraulic loading conditions, four subsurface flow wetlands exhibited certain fluctuation for total organic carbon removal. But generally speaking, compared to the vertical flow wetlands, horizontal flow wetland total organic carbon removal was significantly better in two horizontal flow wetland effluent concentration range of 8.25-26.68 mg/L, the removal rate in the range of 17.1 to maintain 81.3 %, although volatility is also large, but in local time, remove the horizontal flow ratio of total organic carbon or vertical flow advantage. In both horizontal flow wetlands, the horizontal zeolite wetlands in a certain time on the total organic carbon removal are higher than horizontal limestone wetland, indicating that the zeolite on the removal of organic pollutants have certain advantages.

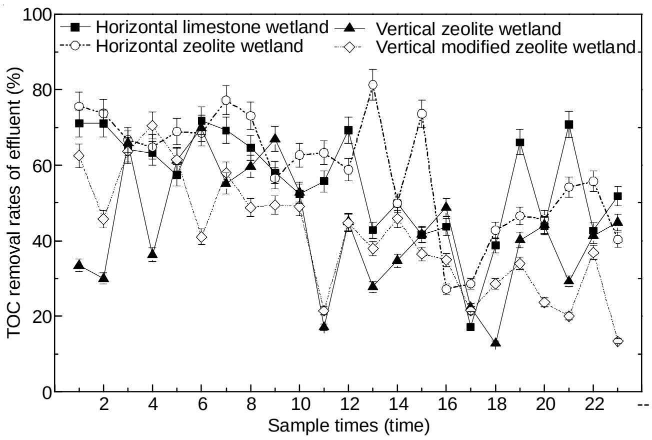

Fig. 2. Removal effect on total organic carbon in every wetland under optimal hydraulic loading

And in both vertical flow wetland, initially alternating between each other for the highest total organic carbon removal, while the final phase of the trial and the vertical compared to modified zeolite, vertical zeolite wetlands gradually becoming the total organic carbon removal at a high level.

Conclusion

In summary, the four subsurface wetlands showed different behaviors for organic removals. The chemical pollutant indexes of chemical oxygen demand and total organic carbon were analyzed for evaluating the removal efficiency of pollutants from the secondary effluent of wastewater treatment plant. Meanwhile, horizontal subsurface wetlands exhibited more remarkable removal effects on chemical organics. Total organic carbon and chemical oxygen demand removal could achieve 81.3 and 82 %, respectively.

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