



Treatment of High Polluted Leachate by Subsurface Flow Constructed Wetland with Vetiver

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ABSTRACT: Landfill leachate usually contains high concentrations of pollutions that are seriously harmful to the environment and human health. The main purpose of this study was removing organic pollution, ammonia, nitrate and total nitrogen in Isfahan composting facility leachate by horizontal constructed wetland systems. A pilot-scale study was conducted on subsurface flow constructed wetland systems operated in horizontal mode (HFCWs). Two horizontal systems with different plants were constructed, one planted with Vetiver and the other one without plant as a control. They were operated identically at a flow rate of 27 L/day with a 5 day hydraulic retention time. The average removal efficiencies for control and experiment were BOD₅, 9% and 30%; COD, 19 and 34%; TN, 37 and 50%; Ammonium, 8 and 26%; nitrate 33 and 40% respectively. Due to high concentration of pollutants (the mean leachate concentrations of COD, BOD₅, TSS, NH⁴⁺-N, NO³⁻-N, TN were 104514.9, 69200.0, 8478.3, 317.5, 4633.2 and 1500 mg/L, respectively) the subsurface flow constructed wetland systems with Vetiver plant is a suitable solution for leachate treatment.

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1- Introduction

During collection, transportation, delivering and processing of solid waste in composting facilities, due to high concentrations of pollutants and high humidity in municipal solid wastes (MSW), a concentrated leachate would be produced. A constructed wetland is an engineered wetland created as a new solution for treating the wastewaters, storm water runoff, industrial wastewaters, landfill leachate and agricultural wastewater.

The treatment of solid waste leachate with conventional methods such as activated sludge, reverse osmosis, ultrafiltration and chemical flocculation requires high technology, operation and maintenance costs. So the use of constructed wetland has been considered as sustainable solution for treatment of solid waste leachate. Available reports on CWs treating landfill leachate indicate that the systems in operation have been constructed with a depth of about 0.4–0.7 m. Previous studies showed that Vetiver has the capacity to withstand a high concentration of pollutants and able to grow well in extreme soil conditions including heavy metals, landfill leachate, etc.

2- Methodology, discussion and results

Feed substrate used in this study was 2 years old leachate which was obtained in spring season from an open lagoon

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located at Isfahan composting facility located at eastern of Isfahan, Iran. The study was carried out in two horizontal subsurface wetland systems (stainless steel, 0.5×0.5×1.2 m (width×depth×length)) with continuous flow. One of them operated as a control (without plants) and the other one operated as an experiment. The system filled with gravel (0.5-4 cm diameter, porosity of 25%) in the inlet and outlet area. The remainder part of the bed filled with sand (1-5 mm diameter, porosity of 88%) and 1% bed slop. The leachate was fed to the systems continuously by a regulating valve, with a 27.6 L/day flow rate and was 5 days HRT).

The efficiency of the systems was estimated by measuring organic and inorganic parameters. 200 ml samples were collected from both influent and effluent of each CW with 5 days interval. pH, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Total Nitrogen (TN), ammonium nitrogen (NH⁴⁺-N), Nitrate Nitrogen (NO³⁻-N) were analyzed according to standard methods for water and wastewater examination (APHA, 1998).

In all cases, significance was defined by p<0.05. Test for significant difference between treatments was done using the Scheffe test performed of variance.

Table 1 showed the concentrations of inflow, outflow and efficiency of pollutants in control and experiment CWs.

After the treatment using horizontal subsurface flow constructed wetland with Vetiver, it decreased steadily over

Table 1. Summary of the monthly performance of the wetland systems

| Parameter | Inflow (mg/L) | Out control CW (mg/L) | Out experiment (mg/L) | Control eff. (%) | Experiment eff. (%) |
|--------------------------------|---------------|-----------------------|-----------------------|------------------|---------------------|
| N-NO ₃ ⁻ | 4633.20 | 3059.07 | 442.57 | 33.67 | 39.57 |
| N-NH ₄ ⁺ | 317.48 | 292.12 | 235.68 | 8.62 | 25.14 |
| TN | 1500.00 | 900.00 | 700.00 | 37.40 | 49.75 |
| BOD ₅ | 69200.00 | 62791.57 | 48625.00 | 9.24 | 29.62 |
| COD | 104514.89 | 83666.07 | 69475.87 | 19.90 | 33.43 |

time until the plants aged. This was due to converting nitrate to nitrogen gas through denitrification and removing some of the leachate's nitrogen. The removal mechanisms for TN also included uptake by plants and micro-organisms, ammonification, nitrification, denitrification, ammonia volatilization and cation exchange for ammonium. The major mechanisms for BOD and COD removal were sedimentation and filtration of suspended solids in gravel bed, plant uptake and biological degradation of organic substances by attached growth micro-organisms under aerobic, facultative and anaerobic conditions in the top (rhizosphere), middle and bottom zones respectively.

3- Conclusions

Constructed wetlands with horizontal subsurface flow (HF CWs) have successfully been used for treatment various types of wastewater. Most systems have been designed to treat municipal sewage but the use for wastewaters from agriculture, industry and landfill leachate in HF CWs is getting more attention nowadays. This pilot scale constructed wetland experiment proved that a Vetiver constructed wetland with horizontal flow has great potential in treatment of highly concentrated leachate of MSW. The highest average inflow concentrations of BOD₅ (75000 mg/L) and COD (113265 mg/L) were reported in this study. In this study by constructed wetland technology using Vetiver, there is a goodish reduction in TSS, BOD, COD, NO₃⁻ and NH₄ in MSW leachate.

• Vetiver had proven a very resistant plant in treating leachate and very high interval pollutions, according to the results of this study.

• The result of control CW had proven a good removal of pollutions from initial leachate with sand and gravel.

• Highest reduction efficiencies were recorded for TN with 49.75% and Cr with 53.22%.

Finally, it was observed that CW is cost-effective and environmental friendly technology and can be used for treatment of leachate.

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