Treatment of Domestic Waste Water by Small Scale Constructed Wetland Under Different HRT Regimes

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Abstract

Constructed wetlands (CW) have been considered cost-effective bioremediation systems for the removal of contaminants in waste water of domestic and commercial origin. In the present study small scale prototype free water surface (FWS) constructed wetland (CW) system was used for the treatment of domestic waste water under different hydraulic retention time (HRT) (2.5 hrs, 4, 8, 12, 16, 20 days). The wetland was consisted of three laboratory-scale units (4′×5′×1.5′) of plexiglass; the first two units were containing beds of gravel (7.5 cm), sand (15 cm) and organic soil (12.5cm), planted with a common grass (*Paspalum flavidum*) and the third unit was just a bed (35 cm) of sand. In continuous treatment mode (2.5 hrs HRT), there was observed a considerable improvement in water quality parameters in terms of COD (72.20%), BOD_5 (72.20%), sulphates (50.74%), chlorides (63%) and microbial count (*E. coli*, *Salmonella* and *Klebsiella*) [MPN index (99%)] removal. Further increase in HRT proved to be significantly correlated with the treatment efficiency of the system.

Introduction

- **Untreated sewage and fresh water contamination:**
  - A major cause of infectious diseases (5.7% of total load) throughout the world.
  - About 30% of the disease load and 40% of the mortalities in Pakistan.
  - Only 10% of the municipal and industrial effluents are treated at primary level and the remaining are disposed off as such in water ways.
  - Cost effective waste water treatment and water reuse systems are highly required in countries facing economic and power shortage issues.
- **Constructed Wetlands (CW):** A cost-effective solution for waste water treatment in a partially controlled environment where plants and rhizospheric microflora work synergistically in removing contaminants.

Objectives

- Construction and operation of FWS constructed wetland.
- A comprehensive approach towards waste water treatment in terms of;
  - using multiple treatment units of soil, sand and gravel (planted or unplanted).
  - considering 13 different physico-chemical and microbiological parameters of raw and treated waste water.
  - using a range of HRT (s).

Acknowledgement

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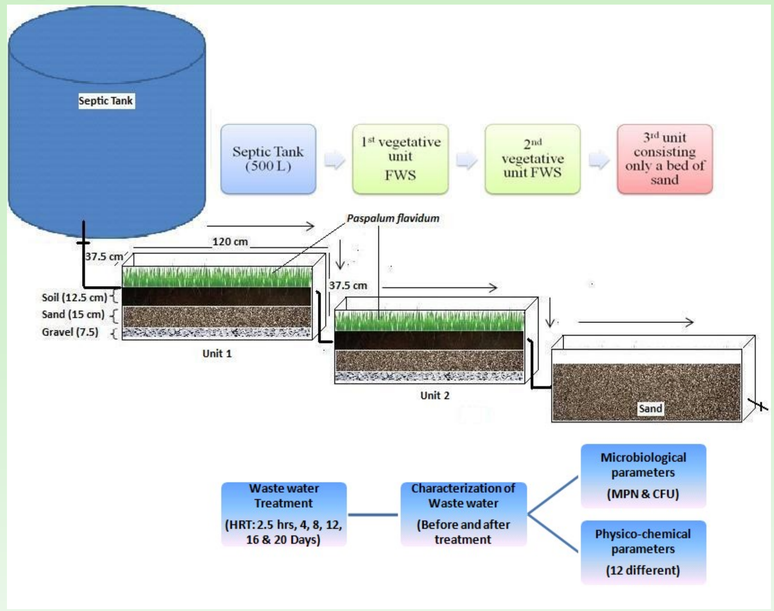
Experimental



Construction and Operation of FWS CW

Analytical Parameters	Method	Reference
Odor	Sensory test	2150 A (APHA, 21st edition)
BOD_5	5-day BOD test	5210 B (APHA, 21st edition)
COD	Closed Reflux, Titrimetric Method	5220 C (APHA, 21st edition)
Total solids (TS)	Total solids dried at 103-105 °C	2540 B (APHA, 21st edition)
Total dissolved solids (TDS)	Total dissolved solids dried at 180 °C	2540 C (APHA, 21st edition)
Total suspended solids (TSS)	Total suspended solids dried at 103-105°C	2540 D (APHA, 21st edition)
Chlorides	Titration method using silver nitrate	Christian, 2004
Alkalinity	Titration method	2320 B (APHA, 21st edition)
Orthophosphates	Stannous chloride method	4500 P (APHA, 21st edition)
Sulphates	Barium chrometery	EPA method (0375)
Nitrate nitrogen	NO_3-N method	4500 (APHA, 21st edition)
Nitrite nitrogen	NO_2-N method	4500 (APHA, 21st edition)
MPN		9221 C (APHA, 20st edition)
CFU	Serial dilution and Plate count	9215 A (APHA, 20st edition)

Results

- Waste water treatment efficiency of the FWS CW varied from 50 - 99 % among different pollution indicators at 2.5 hr HRT . Though, it was comprehensively achieved after given maximum HRT of 20 days.
  - Comparatively, the 1st treatment unit (vegetative) of the CW gave maximum efficiency followed by 2nd and then 3rd.
  - The specific removal rates (per hr HRT basis) of different pollution indicators versus different HRT(s) are;
    - 76 % in BOD & COD with 87% increase in DO.
    - 45 % in Chlorides and Orthophosphate.
    - 30-35 % in Nitrite & Nitrate.
    - 60 % in Sulphates.
    - 90-100% in Odor, Microbial count (MPN Index & CFU) and Turbidity.

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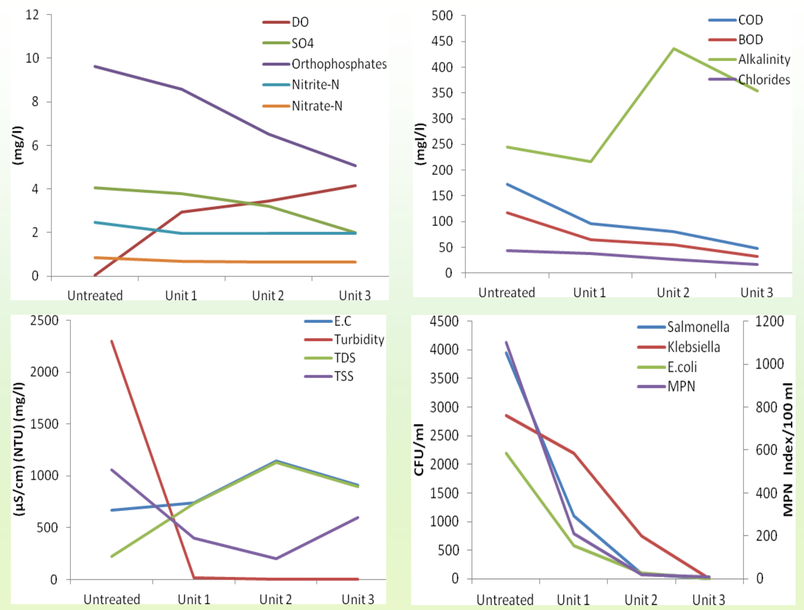
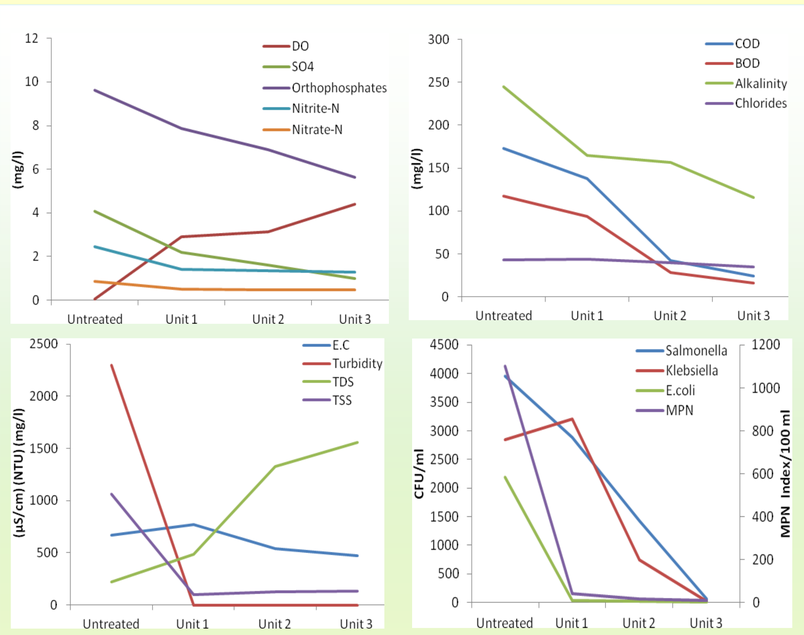
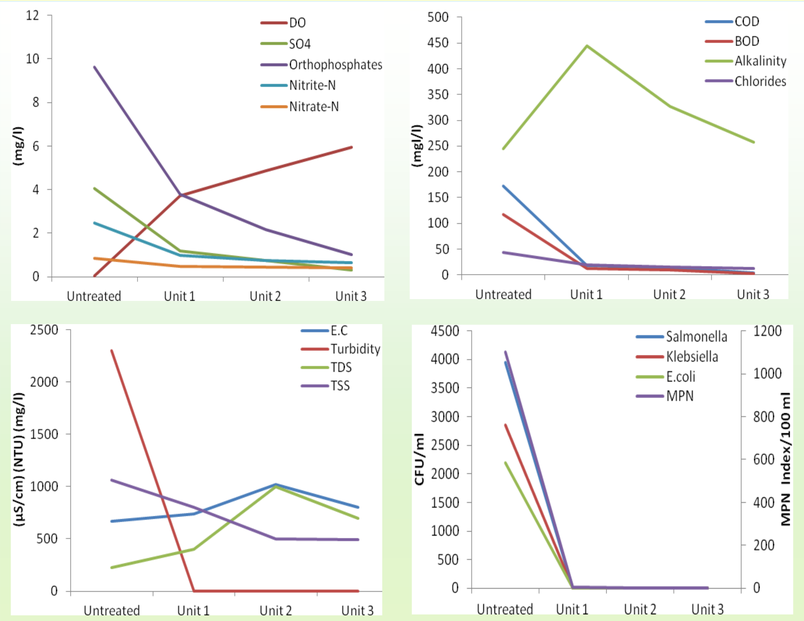


Physico-chemical and Microbiological characterization of waste water after 2.5 hr HRT (continuous mode) through FWS CW



Physico-chemical and Microbiological characterization of waste water after 4 days HRT through FWS CW



Physico-chemical and Microbiological characterization of waste water after 20 days HRT through FWS CW