Bioresource Technology 128 (2013) 438–447

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

A lab-scale study of constructed wetlands with sugarcane bagasse and sand media for the treatment of textile wastewater

Tanveer Saeed [a,*], Guangzhi Sun [b]

[a] Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh
[b] School of Engineering and Physical Sciences, James Cook University, Townsville, QLD 4811, Australia

HIGHLIGHTS

- ▶ Higher media porosity of sugarcane bagasse media allowed oxygen diffusion.
- ▶ C leaching from the organic media supported denitrification in VF reactors.
- ▶ Anaerobic conditions accelerated color removal in HF wetland reactors.
- ▶ The wetland systems showed stable removal performances under unsteady loadings.
- ▶ Constructed wetlands can be employed as alternative technologies in Bangladesh.

ARTICLE INFO

Article history:
Received 17 August 2012
Received in revised form 9 October 2012
Accepted 11 October 2012
Available online 23 October 2012

Keywords:
Constructed wetlands
Media
Nitrogen
Organics
Shock load

ABSTRACT

This paper reports the pollutant removal efficiencies of two lab-scale hybrid wetland systems treating a textile wastewater. The two systems had identical configurations, each consisting of a vertical flow (VF) and a horizontal flow (HF) wetland that were filled with organic sugarcane bagasse and sylhet sand as the main media. The systems were operated under high hydraulic loading (HL) (566–5660 mm/d), and inorganic nitrogen (254–508 g N/m^2 d) and organics loadings (9840–19680 g COD/m^2 d and 2154–4307 g BOD$_5$/m^2 d). Simultaneous removals of BOD$_5$ (74–79%) and ammonia (59–66%) were obtained in the first stage VF wetlands, demonstrating the efficiency of the media for oxygen transfer to cope with the high pollutant loads. The organic carbon (C) content of sugarcane bagasse facilitated denitrification in the VF wetlands. Second stage HF wetlands provided efficient color removal under predominantly anaerobic condition. Overall, the wetland systems showed stable removal performances under high, and unsteady, pollutant loadings.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

As a wastewater passes through the media of a subsurface flow constructed wetland, various physicochemical and biological processes contribute to the net removal of pollutants from the wastewater (Saeed and Sun, 2011b). In order to enhance the pollutant removal efficiency of a subsurface flow wetland, recent studies have investigated the effects of major environmental and operation factors and alternative arrangement of wetland media in multiple-stage wetland systems (Sun et al., 2007; Saeed and Sun, 2012). It has been reported that improvement in treatment efficiency (in terms of pollutant mass removal per unit area or percentage removal) can be achieved through external addition of organic C to enhance heterotrophic denitrification (Laber et al., 1997), effluent recirculation (Ayaz et al., 2012), and alternative influent feeding modes (i.e. tidal flow, step feed, and upflow mode) (Ong et al., 2010; Stefanakis et al., 2011; Wu et al., 2011). More recently, the implementation of baffled wetlands (Tee et al., 2012) demonstrated enhanced removal performances, due to effective use of aerobic-anaerobic regions of the employed matrices. However, some of these variations require complicated arrangement and setup that incur significant operating and maintenance costs.

Alternative arrangement of wetland media, which generates the necessary conditions to ‘coordinate’ various microbial degradation processes, can be an attractive and economical option for enhancing the performances of subsurface flow wetlands (Sun and Heimann, 2012). A limited number of studies have been carried out on alternative media in wetland systems; for example: zeolite (Yalcuk and Ugurlu, 2009), slag (Cui et al., 2010), light weight aggregate (Białowiec et al., 2011), and alum sludge (Zhao et al., 2011). These studies generally reported improved performances in the removal of common pollutants (such as organics, suspended solids, and phosphorus) from wastewaters.

* Corresponding author. Tel.: +880 29897311; fax: +880 29860564.
E-mail addresses: tanveer@alumni.ait.asia, tanveer.ce@aust.edu (T. Saeed).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.10.052

For improving the removal of nitrogen from wastewater, wetland media that are rich in organic C contents have been tested (Saeed and Sun, 2011a; Saeed et al., 2012; Tee et al., 2012). These studies reported simultaneous nitrogen and organics removal rates (from tannery and domestic wastewater), which could be attributed to the unique physical and chemical properties of organic media. As such, organic media can be employed as the main media in subsurface flow wetlands, to provide efficient treatment of wastewaters that contains recalcitrant compounds, such as textile effluents.

Only a few studies have been carried out on the treatment of textile wastewaters using constructed wetlands (Mbuligwe, 2005; Bulc and Ojstršek, 2008; Ong et al., 2009, 2010). Most of these studies used artificial dyeing wastewater. Experiments with real textile effluent are critical to test the potential of the wetlands in such application. In addition, it is necessary to study the performance stability of the wetland systems, when unexpected 'shock' loadings and variations in operating conditions occur, which are common scenarios in industrial wastewater treatment systems (Boller, 1997).

This study was designed to assess whether two locally available materials (i.e. organic sugarcane bagasse – a waste by-product, and sylhet sand) were suitable wetland media for the treatment of a real textile wastewater in Bangladesh. The main objective of the study was to understand the efficiency and stability of system performance, in terms of removing nitrogen, organics, solids and color imparting compounds from the wastewater, when two hybrid wetland systems were operated under high pollutant loading, coupled with sudden variation (shock load) of operating conditions.

2. Methods

2.1. The textile wastewater

The textile wastewater was collected from a local dyeing factory in Dhaka, Bangladesh, and transported to the experimental site. The wastewater was stored in a feed tank, before being dosed into the wetland systems.

2.2. The lab-scale wetland systems

Two lab-scale hybrid systems of the same configurations, namely system 1 and 2, were built on campus (outdoors) at Ahsanullah University of Science and Technology in Dhaka, Bangladesh. Each system consisted of two treatment stages: a VF wetland (A), followed by a HF wetland (B), as shown in Fig. 1.

Two locally available materials, organic sugarcane bagasse (size 2.4–9.5 mm) and sylhet sand (size 300.0–600.0 μm), were used as the main media in the VF and HF wetlands, respectively. The bagasse was a by-product of sugarcane processing, which contained 40% cellulose, 24% hemicellulose, and 25% lignin, according to Lee (2005). The packed porosity of the media was measured as 69% and 26% for sugarcane bagasse and sylhet sand, respectively.

The height and diameter of each VF wetland were 1.50 and 0.15 m, respectively. The length, width and depth of each HF wetland were 1.01, 0.45 and 0.70 m, respectively. In each VF wetland, the layer of main media (sugarcane bagasse) was 1.4 m deep, overlying on round stones (0.1 m depth). In each HF wetland the sylhet sand media was 0.65 m deep.

Three types of locally available macrophytes, *Phragmites australis*, *Dracaena sanderiana*, and *Asplenium platyneuron*, were planted into the wetlands. *P. australis* was collected from a local water channel, whereas the other two species were collected from a local nursery. The first stage VF wetlands (A) of both systems were planted with *P. australis* and *D. sanderiana.* The second stage HF wetlands (B) were planted with all three species. After plantation all the wetlands were water-logged for ten weeks, allowing the establishment of the macrophytes.

2.3. System operations

After the establishment of the macrophytes, the two systems were fed with raw textile wastewater for a total of 15 weeks. Wastewater sampling and quality analyses were performed during the last 10 weeks of this period.

Textile wastewater was dosed manually into the first stage VF wetlands A_1 and A_2 of system 1 and 2 (Fig. 1), five times a day,

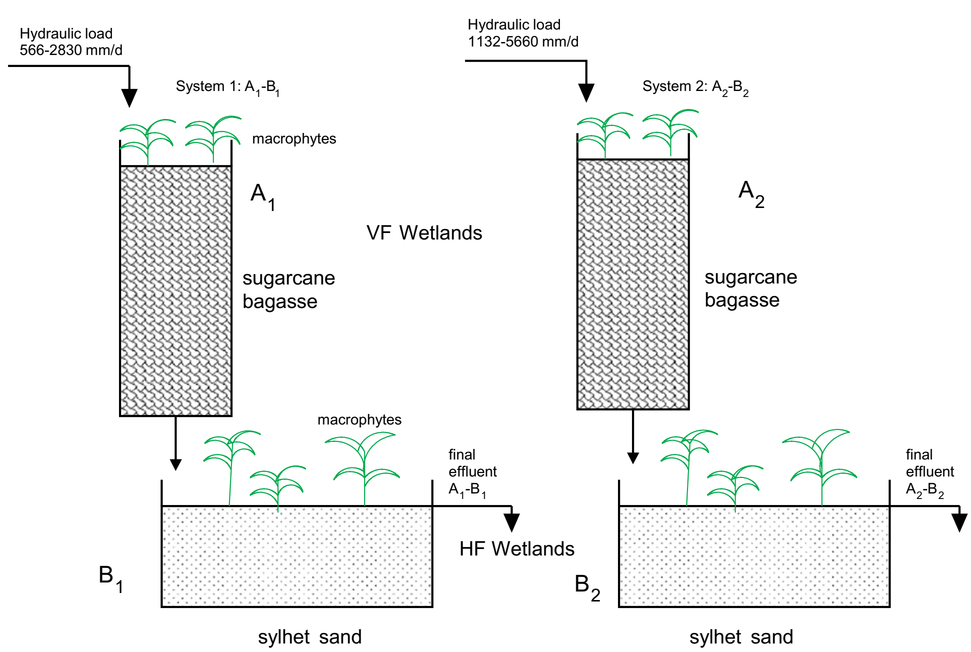

Fig. 1. Experimental arrangement of the two parallel hybrid wetland systems.

Download English Version:

https://daneshyari.com/en/article/7084903

Download Persian Version:

https://daneshyari.com/article/7084903

Daneshyari.com