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

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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.

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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.

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 set-up 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.

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