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Phytoremediation of industrial effluent containing azo dye by model up-flow constructed wetland

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Abstract

This study assessed the treatment of azo dye Acid Orange 7 (AO7) containing wastewater by laboratory-scale up-flow constructed wetland (UFCW) with and without supplementary aeration. The supplementary aeration could effectively control the ratio of anaerobic and aerobic zones in the UFCW reactor. The results clearly show the supplementary aeration boosted the biodegradation of organic pollutants and mineralization of intermediate aromatic amines formed by AO7 degradation.

Keywords: Up-flow constructed wetland; Supplementary aeration; Acid Orange 7

The biological treatment of azo dyes containing wastewater generally requires the combination of anaerobic and aerobic processes [1–3]. The azo double bonds can be severed biologically by some anaerobes and the intermediate aromatic amines residues can be further mineralized by aerobic microbes [4]. Thus, the design of constructed wetland for controlling the ratio of aerobic and anaerobic zones in the wetland bed is a key technology to upgrade constructed wetland system enables to treat azo dyes containing wastewater successfully. The up-flow constructed wetland (UFCW) reactors were designed and the feasibility for the treatment of azo dye Acid Orange 7 (AO7) containing wastewater was investigated.

1. Experimental

Two parallel laboratory-scale UFCW reactors (namely aerated and non-aerated) were prepared and located indoors. Fig. 1 shows the schematic diagram of an UFCW reactor. The size of wetland reactor was 18 cm in diameter and 70 cm in height. The reactor was filled with 6 cm glass beads followed by 60 cm of gravel. Five sampling points were tapped along the reactors. The emergent plant used was *Phragmites australis*. In the aerated reactor, two porous air spargers were installed at 30 cm below the bed surface for supplementary aeration. The characteristics of the wastewater were as follows: COD_{Cr} 326 mg/L, AO7 100 mg/L, T-N 62 mg/L, and T-P 5.0 mg/L. Wastewater samples collected in effluent and sampling points were analyzed for COD, AO7 and aromatic amines. HACH DR/890 portable colorimeter was used to determine COD concentration. AO7 concentration and aromatic amines in solution were determined using

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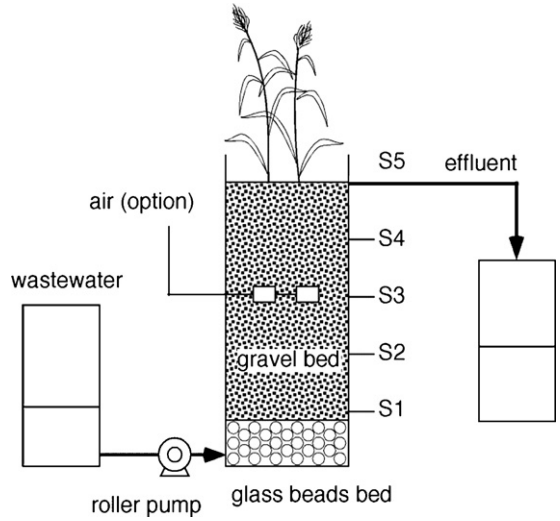

Fig. 1. Schematic diagram of an UFCW reactor.

a UV/vis spectrophotometer (Hitachi U-1100, Japan) at wavelength 480 nm and 248 nm, respectively. ORP monitoring along the sampling points was conducted using an ORP meter (RM-20P, Japan).

2. Results and discussion

The distribution of ORP along the UFCW reactors is shown in Fig. 2. The aerobic and anaerobic zones were well developed, respectively to the upper and lower beds of aerated wetland reactor. On the other hand, the anaerobic condition was covered in almost the whole bed of non-aerated wetland reactor except at the top layer of reactor. The aerobic and anaerobic zones in these UFCW reactors will influence the activity of microbes in the decolorization of AO7 and mineralization of intermediate aromatic amines.

Fig. 3 shows the time course study for COD and AO7 concentrations throughout the experiment in each UFCW reactor. The COD concentration in the synthetic wastewater containing 100 mg/L AO7 was about 450 mg/L. The average COD removal efficiency in the aerated and non-aerated reactors was 86% and 75%, respectively. The lower COD removal efficiency in the non-aerated reactor was ascribed to the accumulation of aromatic amines formed by AO7 degradation. The COD removal efficiency in the non-aerated reactor was quite stable throughout the operation compared to the aerated reactor. The COD removal efficiency in the aerated reactor decreased in the first 2 months of operation then gradually improved till the end of the experiment. This was corresponding to the removal efficiency of

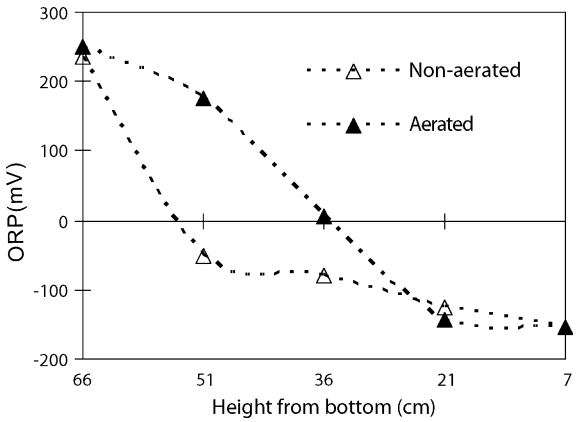

Fig. 2. ORP profile in UFCW reactors.