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The removal of heavy metals in wetland microcosms: Effects of bed depth, plant species, and metal mobility

Asheesh Kumar Yadav [a,b,*], Rouzbeh Abbassi [b], Naresh Kumar [c], Santosh Satya [d], T.R. Sreekrishnan [e], B.K. Mishra [a]

[a] CSIR-Institute of Minerals and Materials Technology, Bhubaneswar 751 013, India
[b] Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ 08544, USA
[c] Department of Environmental Science and Engineering, Guru Jambheswar University of Science and Technology, Hisar 125 001, India
[d] Centre for Rural Development and Technology, Indian Institute of Technology Delhi, New Delhi 110 016, India
[e] Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, New Delhi 110 016, India

HIGHLIGHTS

- ▶ Systematic study of effect of bed depth in order to develop compact wetlands.
- ▶ Accumulation, translocation and bioconcentration of heavy metals in plants species.
- ▶ Performance comparison of three different plant species planted constructed wetlands.

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ABSTRACT

The present study deals with comparative evaluation of three different plants species, i.e. *Canna indica* L., *Typha angustifolia* L. and *Cyperus alternifolius* L. planted vertical constructed wetlands (CWs) microcosms for Cu, Cr, Co, Ni and Zn removal from aqueous solution. The effects of depth of the gravel beds were also studied in order to explore possibilities of development of compact constructed wetlands. Linear regression analysis was carried out for predicting the final removal efficiencies by variation of the treatment time and the bed depth of filter materials. To determine the removal mechanism and mobility of heavy metals in constructed wetlands, accumulation of these metals in gravel, roots, stem and leaves of plant species were investigated. Results demonstrate that the wetland bed depth has significant, direct effect on final heavy metal removal efficiencies. Considering three different plant species, Zn removal was found to be highest (99.3% in *T. angustifolia* planted CWs in 72 h of treatment time), and Co removal was found to be lowest (54.6% in *T. angustifolia* planted CW in 72 h of treatment time).

1. Introduction

Heavy metals in water are potentially hazardous to public health. Their high dissolved concentrations in drinking water may damage nerves, liver, bones, block functional groups of vital enzymes and are possible human carcinogens (group 2B) [1–3]. Various industrial processes result in the generation of metal containing waste streams. The removal of toxic heavy metals from industrial wastewaters using conventional physico-chemical approaches such as adsorption [4–6], oxidation and reduction and chemical precipitation [7,8], among others are generally not cost effective at a larger scale. These processes also require large quantities of chemical reagents and produce a considerable amount of toxic sludge and secondary pollutants, thus raising questions about the sustainability of these technologies. Operational costs for wastewater treatment processes increase for waste streams having complex organic matter and relatively low metal concentrations [9].

In recent years, interest has been growing in treating municipal and industrial wastewaters through CWs as an alternate to conventional treatment technologies [10–12]. CWs are comparatively less expensive in terms of construction and operational cost. They are also considered as more tolerant to varying environmental conditions and pollutant shock loadings [13]. Field applications of these systems have been already reported for domestic wastewaters management, agricultural wastewaters, landfill leachate, storm water and industrial effluents such as mining, pulp and paper and textile [14–17]. However, this technique has not yet been

* Corresponding author at: CSIR-Institute of Minerals and Materials Technology, Bhubaneswar 751 013, India. Tel.: +91 674 237 9360; fax: +91 674 258 1160.
E-mail address: ashyaduvanshi@yahoo.co.in (A.K. Yadav).

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