MATHEMATICAL MODELLING OF CADMIUM REMOVAL FROM DOMESTIC WASTEWATER IN CONSTRUCTED WETLANDS USING A DYNAMIC MODEL

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ABSTRACT

A mathematical model was developed to simulate cadmium removal from wastewater in free water surface (FWS) and subsurface flow (SF) constructed wetlands using STELLA simulation program. The model simulated the accumulation of cadmium in soil (Cds), uptake by plants (Cdp), and residual concentration in effluent (Cdww_eff). The experimental data used for the model calibration and validation were obtained from an earlier study on cadmium removal in FWS and SF constructed wetlands under different environmental conditions. In that study, a synthetic wastewater resembling domestic sewage was used with cadmium (Cd) concentrations of 1, 5, 10, and 20 mg/L for four experimental runs (Run I to IV). Each experimental run was conducted consecutively while changing the cadmium concentrations in the influent. The constructed wetlands were divided into four compartments along their lengths. The Cd removal in each compartment of the wetland could be accounted in terms of the concentration in plants (Cdp), in wastewater (Cdww), and in soil (Cds), respectively. The model was calibrated using one-half of the experimental data for the adjustment of the coefficients and subsequently the remaining data were used for model validation. Once the model was calibrated and validated, a sensitivity analysis was conducted to identify those parameters that have the maximum impact on model predictions. Finally, a statistical analysis was used to compare differences between experimental and simulated average cadmium removal efficiencies. The comparison of simulated and experimental values of Cds, Cdp, and Cdww_eff showed good agreement (t-test p value, p = 0.755). Results indicated that the developed mathematical model could be useful for predicting the fate of cadmium when treating domestic effluents in constructed wetlands.

KEY WORDS: CONSTRUCTED WETLANDS/ CADMIUM/ MATHEMATICAL MODELLING

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