

Nitrate Removal from Groundwater Using Constructed Wetlands

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ABSTRACT: To investigate the kinetic behaviors of nitrate removal from groundwater using constructed wetlands, this study set up two flow-through pilot-scale constructed wetlands with the same areal size but various flow patterns (free water surface flow (FWS) and subsurface flow (SF)) to receive a synthetic nitrate contaminated groundwater at a target concentration of 20 mg NO₃-N L⁻¹. These two wetlands were operated at nearly identical hydraulic loading rate (HLR) in every trial and sequentially run in various trials with different HLRs ranging from 0.02 to 0.27 m d⁻¹. Nitrate removal rates of both wetlands increased with increasing hydraulic loading rate until a maximum value was reached. The maximum removal rates, occurred at HLR of 0.12 and 0.07 m/d, were 0.910 and 1.161 g N/m²/d for the FWS and SF wetland, respectively. After the maximum values were reached, further increasing HLR led to a considerable decrease in nitrate removal rate. Nitrate removal efficiencies remained high (>85%) and effluent nitrate concentrations always satisfied drinking water standard (< 10 NO₃-N/L) when HLR did not exceed 0.04 m/d for both FWS and SSF wetlands. As HLR was greater than 0.4 m/d, effluent nitrate significantly increased and removal efficiency considerably decreased with the increase of HLR. The longitudinal transect nitrate data show that the SF wetland exhibited a first-order plug-flow reactor profile, while the FWS wetland diverged from a plug flow response. The first-order nitrate removal rate constant, determined either from longitudinal transect data or influent-effluent data, tends to decrease with increasing HLRs, which may be due to increase of nitrate loading rate decreasing the denitrification rate in wetlands. The FWS wetland provided significantly higher (*p*<0.05) organic carbon in effluent than the SF wetland, while the SF wetland exhibited significantly (*p*<0.05) lower effluent DO than the FWS wetland. However, there was no significant difference (*p*>0.05) in nitrate removal performance between the two types of constructed wetlands in this study except in one trial operating at HLR of 0.06~0.07 m/d.