SYMP-03

Nitrogen Cycle: Measurement and Modeling of Nitrate-N Transport in Subsurface Bioreactors

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Abstract

In subsurface bioreactors used for tile drainage systems, carbon sources are used to facilitate denitrification. The objectives of this study were to estimate hydraulic conductivity, specific storage coefficients, effective porosity, dispersivity, and first-order decay coefficients, and to numerically model nitrate-N transport through laboratory- and field-scale bioreactors with woodchips as the carbon source. The laboratory-scale bioreactor used in this study consisted of a polyvinyl chloride (PVC) pipe (0.254 m in diameter and 6.1 m in length) filled with woodchips, with a drainage control structure attached to each end. The dispersivity and the first-order decay coefficient of the bioreactor were determined to range from 9.5 to 32.5 cm, and 0.0025 to 0.14 hr-1, respectively without any temporal or spatial trend. In a field-scale bioreactor (6.1 m by 6.1 m) installed at Decatur, IL nitrate-N concentrations were monitored in 16 monitoring wells installed at 1.5 m intervals and 0.75 m from each corner. A Finite Element Method routine was used for transient, two-dimensional groundwater flow, and the Random Walk Method was used for two-dimensional nitrate-N transport. The storage coefficient, the dispersivity, the first-order decay coefficient, and the effective porosity were estimated as 0.18 cm-1, 16.7 cm, 0.2 hr-1, and 0.86, respectively. High reduction rate of nitrate-N in mass (approximately 55%) was observed at the outlet of the field-scale bioreactor at relatively low retention time (2.8 hr). This result suggests that field-scale bioreactors may be used to provide significant nutrient reduction from tile-drained fields.

Keyword: Advective-Dispersive-Reactive Model, Nitrate-N transport, Denitrification, FEM, Random Walk Method