Comparative analysis of hydrodynamics of treatment wetlands using finite volume models with empirical data

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Abstract

A numerical visualization study of wetlands is detailed in this article using finite volume methods. The aim of this study is to model treatment efficiency of the wetlands in terms of the residence time distribution function. Shape and depth of wetlands are critically analysed to find the optimal flow requirement for effective treatment. Laminar three-dimensional flow dynamics is used to simulate the slow water flows that occur in treatment wetlands. Slow inlet flows are assumed. Dye is used as the tracer to characterize the hydrodynamics within the wetlands. Three different geometrical configurations, namely square, square with two islands, and triangle, respectively, are simulated. The variation in the tracer concentration is studied as a function of recirculation volumes, flow rates, time and depth of the wetland for each of the wetland shapes. The change in the variation of tracer concentration at inlet and exit helps to assess treatment effectiveness. In another case, glycerine is used to simulate sewage flow. Plug flow is prominent in sewage-laden wetlands. The results obtained from the above-illustrated case studies are compared with each other to assess the reproducibility of the optimal flow model. Multi-parameter regression models for residence time distribution functions are derived to characterize flow through constructed wetlands of different shapes.

Keywords: Wetlands; Shape; Depth; Numerical; Residence time; Visualization; Tracer; Dye

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