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Analytical solution to two-dimensional advection-dispersion equation in cylindrical coordinates subject to finite exit boundary

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Many important sources of subsurface contamination come from ground surface. Surface pollutant may easily move from the top soil to the unconfined aquifer. The filed tracer infiltration test is an efficient method for determining the longitudinal and transverse dispersion coefficients in subsurface soil. This study presents the exact analytical solutions for solute transport in an infiltration tracer test. The two-dimensional advective-dispersive transport in cylindrical geometry, finite-length medium subject to the third-type inlet boundary conditions is solved using the second kind finite Hankel transform and the generalized integral transform technique The developed analytical solutions are compared with the solutions for semi-infinite domain available in literature to illustrate the impacts of the inlet and outlet boundary conditions. Results show that the exit boundary conditions have pronounced impacts on the breakthrough curves for small Peclet number. The solution for the finite-length exit boundary condition predicts lower concentrations than the solutions for the infinite-length boundary condition. The influences of exit boundary conditions diminish when Peclet numbers increase. Numerical evaluations of the developed analytical solutions for the finite domain suffer from the problem of computationally time-consuming because that the convergences of the series progresses slowly for large Peclet number. The developed solutions for finite domain should be especially useful for interpreting the infiltration tracer test.