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Comprehensive set of analytical solutions for advective-dispersive transport involving a great variety of boundary input, initial distribution and internal source

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The study presents a comprehensive set of analytical solutions for the advection-dispersion equation involving a great variety of boundary input, initial distribution, and internal source. First, we apply the Laplace transform in combination with the Fourier transform to obtain the generalized analytical solution. Based on the generalized analytical solution, we derive a comprehensive set of special-case solutions for some time-dependent initial distribution and internal source described by Dirac delta, constant, Heaviside, exponentially decaying, or periodically sinusoidal functions as well as well as some space-dependent boundary and internal source conditions specified by Dirac delta, constant, Heaviside, or exponentially decaying functions. One of the special-case analytical solutions is verified against the analytical solution in the literature for solute transport associated with combined constant and exponentially decaying boundary input, constant initial distribution, and constant internal source. The results obtained from the special-case analytical solution in this study agree well with the results obtained from the analytical solution available in the literature. Several example applications are given using the comprehensive set of special-case solutions. The great potential benefit from the new solution method is a great flexibility for deriving solution for more complicated boundary input, initial distribution, and internal source. A disadvantage, particularly for the solution involving integration over the space domain, is the increments in the computation time. The solution strategy presented in this study can be extended to deal with problem of the multispecies solute transport associated with arbitrary boundary input, distribution, and internal source.