Novel approximate solutions for solute transport due to injections: considering the scale-dependent dispersion and non-integer flow dimension

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Prior research indicated that the flow dimension in a fractured medium may be of non-integer. In this article, we aim at developing a mathematical model for solute transport problems due to continuous or pulse injection in a non-integer dimensional flow field. The model allows the flow dimension ranging from linear flow to spherical flow. Our model also considers the effect of scale-dependent dispersion. The approximate solutions of the model are derived by applying the arrival times of mean and variance and validated through the comparison with finite-difference solutions of the present model. The results show that the approximate solutions give reasonable predictions when the value of dispersion or flow dimension is not large.

Keywords: solute transport, non-integer flow dimension, approximate solution, scale-dependent dispersion