

Interactive comment on “Analytical model for coupled multispecies advective dispersive transport subject to rate-limited sorption” by Jui-Sheng Chen et al.

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This paper extends the analytical solution approach of Chen et al (2012a, cited in draft) to develop an analytical solution to 1D advective-dispersive transport of solutes undergoing both kinetically-controlled reversible linear sorption and first-order decay leading to a chain of daughter products. The method derivation is detailed and is compared to a Laplace-transform numerical solution for cross-validation. The focal point of the paper is that kinetically-controlled sorption renders fate and transport differently than does equilibrium sorption, and that simulations using the equilibrium sorption assumption erroneously will be wrong, which is not really a novelty or a surprise. It seems to

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me that the real value is the solution itself.

The solution is developed for the case of degradation or decay occurring exclusively in the aqueous (mobile) phase. This is I think critical for the mathematics because otherwise there could be the path C1 -> S1 -> S-2 -> C2, that is, sorption of the parent solution leading S1 which decays to S2 which could then desorb as C2. This path would complicate things mathematically and is not allowed here. The critical reader would prefer to see a justification of this assumption. The authors have not in my view delved into that topic enough here; however, I think that with some reviewing of the literature that they could find cases where sorption blocks decay, specifically for reduction or oxidation of TCE or other chlorinated solvents. Some places to begin looking include Yang et al, J. Contaminant Hydrology vol 211, Yu et al., Env. Science and Tech 2018 ("diffusion-coupled degradation ..."), Seyedabbasi et al., J. Contaminant Hydrology 2012. None of these directly answer the question of whether or not decay of sorbed species is significant or not but with a but more searching one should be able to find more supporting literature. At any rate this assumption requires more support because the entirety of the paper is based upon it.

It may also be instructive to return to the equilibrium sorption case to see what happens when (and when not) the sorbed species undergoes decay. In the "not" case one gets the usual retardation coefficient and in the yes case one gets something more complicated, although it would seem keeping track of time spent sorbed may be useful.

Finally the authors may look into generalizing their sorption model to a memory function form, such as used for multirate mass transfer. It may be the case that their developments here would translate smoothly to such a generalization, which would be quite powerful.

In summary this paper clearly articulates an extension of analytical solution approaches to the case specified, and is a nice contribution. Tim Ginn, Washington State University.

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