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# *Interactive comment on* "Reactive Transport with Wellbore Storages in a Single-Well Push-Pull Test" *by* Quanrong Wang and Hongbin Zhan

**Anonymous Referee #2**

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General comments The authors presented a study to extend the Phanikumar and McGuire (2010) model for the single-well push-pull (SWPP) tests in homogeneous, isotropic aquifers by replacing the oversimplified boundary conditions with more complex conditions to account for wellbore storage effect (the Model). The Phanikumar and McGuire (2010) model is a polar coordinate mathematical model used to interpret SWPP tests involving multi-species reactive transport problems with non-linear reactions. The aim of the study was to reduce the potential errors that may be introduced by ignoring the storage effect in the previous models. The authors verified the accuracy of the Model by comparing the breakthrough covers (BTCs) modeled by the proposed mode with those generated by the Wang et al. (2017) model. The Wang et a. (2017) model is a similar expansion the Phanikumar and McGuire (2010) model



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accounting for wellbore storage with respective to groundwater flow. The difference is that the Model accounts for wellbore effects with respect to solute concentration, in addition to flow. Lastly, the authors used the Model to interpret the breakthrough curves (BTCs) of a SWPP field test reported by McGuire et al. (2002) and compared with interpretation of the same BTCs by the Phanikumar and McGuire (2010) model. I have no issues with how the wellbore boundary conditions are formulated. However, I have concerns on the approach the authors taken to verify the Model, which may cast doubts on the practical usefulness of the Model, in specific: 1) Figure 2 shows the comparison between the BTCs modeled by the Model versus those momlded by Wang et al. (2017). But models were used to model the BTCs of hypothetical SWPP tests in three different porous media of fine, medium and coarse sands with typical hydraulic parameters found in textbooks. Figures 3 and 4 illustrate the differences in the BTCs attributable to the wellbore concentration effects. The authors argued the numerical solution of Wang et al. (2017) was chosen to verify the Model because benchmark analytical solutions of the SWPP test with a finite hydraulic diffusivity are not available up to date. An alternative approach is to verify the Model using a solution given by a widely used modeling software, such as MODFOW-SURFACT or FEFLOW (The authors are incorrect to state that commercial numerical software packages are incapable of accurately incorporating the wellbore boundary efforts). 2) To demonstrate it applicability, the Model was used to interpret the BTCs reported in McGuire (2002) in comparison with the Phanikumar and McGuire (2010) model (Figures 6, 7, and 10). Because both models were able to replicate the BTCs, the authors included additional scenarios with varied parameters to demonstrate the differences between the two models. It would be much more compelling to use the field test whose BTCs could not be replicated by the Phanikumar and McGuire (2010) but can be reproduced by the Model. This would alleviate the concern about the necessity of introducing additional complexity into a groundwater model which is known to be subject to parameter uncertainties. In case that such a field test is not available, the authors may consider using a data set modeled using a modeling sofwware such as MODFOW-SURFACT or FEFLOW. 3) Consider adding a list of acronyms defining the physical meanings of the different symbols. Specific comments 1) Abstract. The abstract should be revised to eliminate the discussion of the details such as the Freundlich, Langmuir and linear sorption models, one-site kinetic sorption model, two-site sorption model, and Monod or Michaelis-Menten kinetics. These are not the core subject of this study. 2) Page 2, line 7. Change to: "the model which is expected to properly represent the physical. . ." 3) Page 2, line 26-27, change to: ". . .however, such model only considered wellbore storage effects with respect to groundwater flow, but not solute concentrations." 4) Page 2, line 33, change to: ". . .concentration of the solute in the wellbore is smaller than that of the original solution. . ." 5) Page 3, line 11. It is incorrect to state that none of the four software packages could deal with multi-species reactive transport problems with non-linear reactions. Both MODFLOW-SURFACT and FEFLOW can. 6) Page 3, line 29. Define hydraulic diffusivity at its first appearance. Hydraulic diffusivity is a term used mostly in soil physics, not groundwater hydrology. 7) Page 7, line 9. Change to: " . . .reactive processes considering wellbore effects not only for groundwater flow but also for solute contrations." 8) Page 9, line 1. It is not clear what does it mean by "Subject to the discharge or recharge of the well,.." Please revise.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-181/hess-2018-181-RC2-supplement.pdf

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