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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 #1

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General comments

Based on Wang et al. (2017) and Phanikumar and McGuire (2010), this study proposes an extended model to interpret single-well push-pull (SWPP) tests in homogeneous reservoirs considering transient flow, well-bore storage and reactive transport. The improvements from Wang et al. (2017) concern the change in boundary conditions to better consider the effect of well-bore storage and the extension to reactive transport involving complex chemical reactions based on Phanikumar and McGuire (2010). To show the interest of this extended model, the authors revisited the interpretation of a published SWPP test data set by McGuire et al. (2002) and compared with the model of Phanikumar and McGuire (2010) (available on-line) used to interpret this data set. The authors highlighted that by neglecting the well-bore storage effects and the finite

aquifer hydraulic diffusivity, it underestimates the dispersivity in this case, which is similar to Wang et al. (2017) conclusion. The influence of hydraulic diffusivity on reactive transport appears negligible except for low hydraulic diffusivity and nonlinear chemical reactions. In my opinion, the uniqueness of estimated parameters appears critical and should be addressed. In order to avoid some confusion, a sensitivity analysis should be also performed. Note that the code appears not available from the authors. Please find more details in the following.

1) The travel distance of the tracer from the tested well cannot be estimated from SWPP test without other information. Consequently, the dispersivity and the porosity cannot be estimated separately. The porosity must be fixed using other information in order to estimate the dispersivity from SWPP data set. It seems here that the porosity was assumed but without saying through which means. In addition, by considering the transient nature of the test, which results in two more parameters, it is not clear how dispersivity and the hydraulic properties can be derived independently using the breakthrough curve (BTC) of SWPP test? This raises the question of the uniqueness of the solution and a sensitivity analysis would be helpful.

2) The discussion concerning the impact of the hydraulic diffusivity must be developed by providing an explanation of the mechanisms involved. Even though such discussion might require additional analysis, a simple discussion that only focus on the impact in the BTC appears relatively limited.

3) The authors stated that by neglecting the effects of well-bore storage in the interpretation of the SWPP test, this could result in great errors. As mentioned by the authors, the BTC appears impacted at the early time (i.e., before the peak) and in terms of amplitude. In addition, as demonstrated by the authors, the first-order reaction rate can be interpreted through a simplified solution. Consequently, the effects of well-bore storage seem to impact only the early time of the BTC but not the late-time behavior, which is actually comparable to hydraulic tests. To evaluate properly the impact on the BTC with the assumptions considered in this work, a sensitivity analysis could be actually

very useful. Indeed, even though the late-time behavior was not the subject of this work, mainly because the reservoir was assumed homogeneous, numerous studies have focused on the late-time behavior of BTC in heterogeneous media.

4) As mentioned by the authors, the dispersivities obtained from the previous study and this study are 0.001 m and 0.015 m, respectively. In the user manual provided by Phanikumar, M.S., 2010, another acceptable simulation was performed with a dispersivity of 0.01 m (page 20), which is closed to the dispersivity obtained in this study. By looking at the values of the hydraulic conductivity and the specific storage in this manuscript, they are both perfectly rounded to 1.0 m/h and 1.0 E-5 1/m. Have these values been fixed? Because the authors stated that the hydraulic diffusivity influences the BTC in SWPP test, could the same match be obtained by fixing the dispersivity at 0.001 m and varying only the hydraulic diffusivity? The question of the uniqueness of the solution appears actually very critical. It is also not clear why the BTC was computed at r = rw + 0.15 m and the impact on the result? The comparison with Phanikumar and McGuire (2010) must be completed by providing their interpretation.

Specific comments

Page 3 – line 2: "Similarly, in the rest phase, the concentration is also not 0": Even though some dead zones in some configurations can impact the concentration at the well-bore, note that this effect can be strongly reduced by pumping the water in the well-bore and injecting clean water at the same rate at the end of the injection.

Page 5 – line 20: Why not write the equation (7) and the others using the pore velocity?

Page 5 – line 29: "The assumption works when the chase concentration is zero" This should be normally the case, isn't it?

Page 8 – line 19: ". . . appears to be accurate and reliable" I would suggest estimating the difference between the two solutions, through for instance an indicator like the mean square residual. This require more points for the solution of Wang et al., 2017.

Page 18 – Figure 2: How do you explain the small oscillation in your solution?

Page 28 – Figure 10: Please add the interpretation of Phanikumar and McGuire (2010) for comparison.

Technical corrections

Page 3 – line 17: remove ", so did Wang et al. (2017)".

Page 3 – line 24: remove "Such an effect is called storage effect of solute transport in this study " as already stated line 2 at the same page.

Page 3 – line 32: remove the extra "the".

Page 9 – line 5 to 10: Please use SI units like m/s for the hydraulic conductivity m2/s for the hydraulic diffusivity or g/l for the concentration.

Page 12 – line 25: Correct "PPTESE" by "PPTEST".

Page 13 – line 22: Remove "In this study" or "of this study".

Page 18 – Figure 3a: Units need to be specified for the concentration. Same comments for the figures 3b, 4 and 10.

Page 23, 24 – Figures 6 and 7: Different units for the time are used while the axes are similar.

Page 27 – Figure 9: Flow velocity is written using qr while it should be vr.

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