

Interactive comment on “Impact of skin effect on single-well push-pull tests with the presence of regional groundwater flow” by Xu Li et al.

Anonymous Referee #3

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General comments

The objective of this paper is to study the impacts of skin effects on Single Well Push-Pull (SWPP) tests for estimating groundwater flow velocity. To this aim, the authors build a numerical model of a SWPP test with skin effects using COMSOL. The model is developed in steady-state condition for a 2D homogeneous aquifer. They validate the numerical model against an analytical solution in the case of a SWPP test with no skin effect and no groundwater flow. The authors show the effects on breakthrough curves (BTCs) of the following quantities: groundwater flow velocity, duration of the rest phase, porosity, dispersivity, hydraulic conductivity of the skin zone, thickness of the skin zone. They conclude the following points: groundwater flow velocity should be considered in order to properly design a SWPP test so that as much tracer as possible

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is recovered; skin effects impact BTCs significantly and should be considered during inverse modelling of SWPP tests in order to estimate the correct flow and/or transport parameters.

The manuscript is generally clearly written. The subject is interesting and useful to the readers of HESS. Indeed, it points out that skin effects should not be neglected when interpreting the results of a SWPP test for parameter estimation, i.e., skin effects must be considered in the mathematical model used to fit BTCs. However, I think that authors should clarify some points, as explained in the following specific and technical comments.

Specific comments:

1. According to lines 114-116, the objective of this work is to study the impacts of skin effects on SWPP tests for estimating groundwater flow velocity. However, the article only shows that the skin effect has a significant influence on the shape of the BTC and on the 2D distribution of concentration. It does not quantify the impacts of skin effects on SWPP tests “for estimating groundwater velocity”. Knowing the impact of skin effects on the estimation of groundwater flow velocity (and of transport parameters) is of primary importance for practical applications. For example, in section 4.1 do the authors manage to estimate correctly the velocity in all cases? Ideally the authors should estimate groundwater flow velocity in the different skin configurations and compare it to the real one. At least, they should reformulate the objective of the paper and give an indication of the expected error on the identified groundwater flow velocity.

2. I am not sure to understand the reason why the authors show the impact of groundwater flow velocity on BTCs (section 4.1). Groundwater flow velocity affects the BTC and that is why SWPP tests can be used to estimate this parameter. It is interesting to better understand how groundwater flow velocity influences the SWPP test. However, it is not clear how this analysis is related to the objective of the paper (assessing the impacts of skin effects on SWPP tests). In the conclusions, the authors points out that

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groundwater flow velocity should be considered in order to design the experiment so that as much tracer as possible is recovered. This could be the reason that justifies section 4.1. Nevertheless, it is not explained how it is related to the objective of the paper.

3. The same remark of point 2. can be done for the analysis of the impact of the duration of the rest phase, of porosity and dispersivity (sections 4.2, 4.3, 4.4).

4. Too many figures are presented: I suggest the authors to choose only the figures which are relevant to the objective of the article. In my opinion, figures 6, 7, 8, 9 are not necessary. Moreover, figures showing results with positive skin effects could be combined with figures showing results with negative skin effects.

Technical corrections:

I.23 “the finite-element COMSOL Multiphysics”: add “software”.

I.27 Dividing streamline: this sentence becomes clear only after having read the article. The authors should explain what they mean by “dividing streamline”.

I.29-30 I think the sentence is not very clear. It could be reformulated as: “a smaller ratio between the hydraulic conductivity of the positive skin and that of the aquifer formation”. Moreover, there is no need here to write the mathematical symbol Δ .

Figure 1 The term “formation zone” is not very clear to me. Maybe it can be changed with “aquifer” or “aquifer formation”. The caption should precise what are S1, S2, S3, S4. The coordinate axes are missing.

I.127 What is the “wellbore effect”? If this is important for the understanding of the paper it should be explained, otherwise it can be removed.

I.152 r was already defined at I.147.

I.159 I think it should be specified that H is head.

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I.200 and I.70 Wang et al (2017) is missing in the references section

I.270 In the section title, symbol τ should be changed with “the duration of the rest phase”?

Figures 10 and 12: The symbol should be Δ and not σ .

Figures 11, 13 Why some of the flow lines are interrupted?

I.331 “In contract to”: I would rather say “In agreement with”

Figure 14 is probably wrong: concentration decreases with r_s , differently from what is said at line 350.

Figures 11, 13, 15 and 17: The skin zone is not very evident in the figures. Maybe it could be highlighted with a thicker line.

Table 1: the skin thickness default value is missing.

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