

Interactive comment on “Transient drawdown solution for a constant pumping test in finite two-zone confined aquifers” by C.-T. Wang et al.

Anonymous Referee #2

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General Comments

1. This paper develops an analytic solution for the estimation of the transient drawdown distribution due to constant-flux pumping from a finite-radius well with skin effect in a bounded confined aquifer. The current solution assumes two pairs of transmissivity/storage coefficient values, one pair for the skin zone (up to some radius r_1) and another for the rest of the aquifer. The current solution generalizes a previous solution developed by some of the authors (Yeh, Yang and Peng, *Adv. Water Resour.*, 26) which was developed for infinite aquifers only. Another major advantage of the present solution is that it includes an infinite series that can be accurately estimated with little effort. The infinite series is much easier to compute than the solution of Yeh et al. (2003)

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which is defined in terms of an integral which is difficult to evaluate accurately because of the singularity at the origin.

2. The mathematical derivation, which uses Laplace transforms and Bromwich contour integral, appears to be valid. The mathematical solution used in particular constitutes an interesting contribution beyond what is already published in the literature. The combination of the Laplace transforms and Bromwich contour integral should be of interest to the readers of HESS. Although the presentation of these methodologies for the derivation of the drawdown solution should be of interest from an academic point of view, I believe the main limitation of this work is that the problem of confined circular aquifer with a pumping well located at the center of the aquifer and zero drawdown at the outer edge of the aquifer is not commonly encountered. The authors should therefore elaborate on the applicability of the solution.

3. Under certain simplifying assumptions (such as late time, infinite aquifer, absence of the skin zone), the solution reduces to previously derived solutions (e.g., Theim solution). However, to further demonstrate the validity of the solution, I would propose that the authors consider comparing, under general conditions, the analytic solution they have developed to the corresponding numerical solution.

4. The presentation of the paper is generally good. The use of the English Language is generally good, but the paper in some locations needs an additional round of editing. The title and abstract reflect well the scope of the paper. The Introduction section has a good summary of the published works related to analytic solutions of the drawdown distribution due to pumping for different configurations. Another interesting feature of the developed solution is that it is expressed in terms of non-dimensional parameters which can help in the analysis of the solution.

Specific comments:

5. Page 9309, line 16 and page 9310, lines 11-12: The authors should elaborate on the statement that the accuracy is to the fifth decimal point. Is this a general statement or

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specific to the problem solved in the paper? Perhaps some figure showing the accuracy as a function of n can be included in the paper.

6. Discussion of Figures 2 and 3: There is no mention of the storage coefficients used for the skin zone and the outer zone of the aquifer.

7. Page 9310 line 24 to page 9311 line 2: The results and discussion section of the papers are too brief. In the potential applications section, the authors mention the possibility of using the developed solution to estimate the parameters of the problem (transmissivity and specific storage of the skin and outer zone, and distance to the edge of the skin zone). I believe the addition of such an application would significantly enhance the manuscript.

8. Page 9311 lines 23-24: The authors state that the non-dimensional time matches well up to $\tau_{ao} < 100$. I think that this is not a general comment, but specific to the problem at hand, in particular dependent on the distance to outer aquifer boundary. The authors should rephrase this statement and consider showing other cases to justify their answer.

Additional Comments

9. Gamma and omega (page 9305 line 6) are not defined.

10. In the mathematical derivation (page 9306, equations 20-24 and other places, it would be helpful if the dimensions of the different variables are specified.

11. Equation 31, page 9308: s_1 is non-dimensional therefore, use another symbol. ω_n is not defined.

12. I suggest that the authors add the Theis solution to Figures 2 and 3.

13. Page 9312, line 26: The word "surprisingly" is not needed here. The large-time solution is expected to approach the steady-state solution.

14. Page 9312 lines 10-11: change to: "... indicating that the drawdown is sensitive to

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contrast in transmissivity for positive skin cases".

Overall, I think this is an interesting solution. I recommend publication in HESS after the authors address the above comments.

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