Interactive comment on “Comparison between constant and variable chlorine decay models applied to urban water supply network” by Ababu T. Tiruneh et al.

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We thank the reviewer for forwarding the evaluation. With due respect to the comment forwarded this is to make further clarification (not necessarily a defence against the comment) that the authors suggested a second order model for the variation of the decay rate constant with initial chlorine dose. The literature available mainly indicated empirical inverse relationship between the decay rate constant and the initial chlorine dose of the form \( K = \frac{1}{a+bC_0} \) where \( C_0 \) is the initial chlorine and \( K \) is the first order decay rate constant. In many cases a graphical description or specification of a numerical range is given to narrate the relationship between initial chlorine and the first order decay rate constant. We believe that our model started from the theoretical foundation of the dependence of the first order decay rate constant with initial chlorine modelled as a second order reaction of the form \( \frac{dK}{dt} = mK^2 \) in which the empirical inverse relation that we mentioned will be a consequence of this general model. It might be helpful to look at the theoretical background of our earlier paper that gives a comprehensive theoretical justidification of our proposed model of the second order nature of the variation of the first order decay rate constant with the initial chlorine dose. We also would like to state that present parallel two reactant second order models work with given initial chlorine dose along with water quality parameters such as chlorine consuming reactants. In other words, the fast and slow reaction rates \( K_f \) and \( K_s \) derived from the model change whenever the initial chlorine dose changes. Leading authors recently suggested a way of handling this variation in this parallel two reactant model that takes account of the effect of initial chlorine dose. In this line it may be helpful to look at the paper by one of the leading researchers (Ian Fischer) who cited the need for research in this direction with the following link:

https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29WR.1943-5452.0001101

We believe that our formal second order model over and above the empirical inverse relation we mentioned can be integrated in such models. We also compared the practical range within which the constant and variable rates modelling differ based on the model we developed and applying it to a real case of a water distribution system and provided the percentage range within which the two models differ and the range of initial chlorine dose for which the percentage difference between the two models is/not significant. Several other researchers also indicated the need for formal modelling approach to the effect of initial chlorine dose and water quality on the decay rate constants suggesting a transition from the now mostly used empirical, regression based relationship.

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