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Drinking Water Engineering and Science Discussions

Interactive comment on "Optimized conditions for application of organic flocculant aids in water purification" *by* P. Polasek

Anonymous Referee #2

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I do not find this paper readily understandable, which I attribute to the overall structure, style and a lack of convergence on the concept of optimised conditions as expressed by the paper's title. Too many redundant aspects are incorporated which result in a somewhat fragmented approach. Conversely, certain relevant information is omitted.

The fundamental message appears to be that organic flocculant aids increase the settling rate if added at (the author's) gamma = 1, or optimum GT using "high rate clarification technology". In the abstract, the only reference to "optimized conditions" refers to the aforementioned gamma (or "measure of flocculation") developed in previous work by the author.

The inclusion of extensive narrative relating to such earlier work should be reduced through reference. As per Referee #1's point 6: This problem stems from the use

of capitalised and abbreviated terminology (POA, IHDS, HRC) rather than simple and concise descriptions. This practice elevates the terminology to an unwarranted status which solicits further definition and extensive explanation.

I believe there is value in the work performed, but this cannot be easily ascertained given the content and style of the paper in its current form. I recommend that the paper be revised and that sufficient results be included to underpin the conclusions.

Specific Comments:

1. Abstract P206.5: Refers to "aggregation – CPE", yet the only results presented in the paper relate to the use of inorganic metal coagulants.

2. P206.18: Table 1 adds bulk but little value and should be removed.

3. Introduction P206.25 to P207.9: This section should be revised as it appears almost contradictory when read in the manner presented (i.e. "reduced quantity of floc carry-over / lower total residual turbidity... and ... higher residual turbidity produced by the non-separable particles").

4. P208.10 and P208.17 (Sections 2 and 3): There is no need to provide an elementary description of organic flocculant aids, which almost implies they are uniquely different from organic polymers in general. Of more benefit would be a well defined characterisation of the polyacrylamides used (in terms of molecular weight distribution, charge density, etc). See the paper of Zhu et al (point 8 below), which illustrates the relevance of molecular weight and charge in such trials. Also refer Yoon et al (Yoon, S.Y., Deng, Y.L., (2004) Flocculation and reflocculation of clay suspension by different polymer systems under turbulent conditions. J. Colloid Interface Sci. 278, 139–145).

5. P209.25: "... but the purified water quality is not impaired." How does this statement equate to the results of Letterman et al and Tambo et al, where deterioration in water quality was observed beyond optimum GT? (Letterman, R.D., Quon, J.E. and Gemmell, R. S. (1973) Influence of rapid-mix parameters on flocculation. J. AWWA, 65(11), 716-

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722); (Tambo, N. and François, R. J. (1991) Mixing, breakup, and floc characteristics. In: Mixing in Coagulation and Flocculation (Eds Amirtharajah, A., Clark, M.M. and Trussell, R.R.) AWWA Res. Foundation, Denver Co, 256-281).

6. There is a distinct lack of sufficient results in the paper to validate any major conclusions. Although at least five primary coagulants are cited, together with three different raw water sources and two polyacrylamides, actual data are not forthcoming and are merely covered by the (approximate) statement "results were very similar" (210.16, P212.14 and P215.27). In lieu of comprehensive results, two "typical" graphs are presented, both of which relate to ferric chloride alone. The passing mention of other primary coagulants used (P210.20 and P211.19-20) and deficit of analytical information seems to defeat the objective of fully understanding the "optimized conditions" implied by the title. Sufficient data concerning the base conditions should be included (raw water, chemicals employed, dosage rates, physical and chemical analyses, etc.). Were no differences observed between the use of metallic and organic polymers as primary coagulants?

7. P210.16 "... results obtained were very similar irrespective of water source." This rather bold statement requires actual values for substantiation. If the results obtained were indeed significantly comparable, then surely this would be worthy of further elucidation, i.e. the notion that application of the (specific) organic flocculant aid is largely independent of the water source and (from point 6 above) the primary coagulation chemicals used.

8. Hypotheses appear to be drawn from an investigation in which a multitude of variables are present (see previous points, together with the additional full-scale data, sludge recirculation, etc.). It is not clear how these variables are accounted for in the results, discussion and subsequent deductions. Several are noteworthy, for example data from Table 2 shows that the initial turbidity may have ostensibly varied from 30 to 690 NTU, temperature from 12 to 25°C, etc. As an example of descriptive methodology and inclusion of base conditions, which would allow other researchers to duplicate

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such experiments, refer to the following paper of Zhu et al where these aspects are clearly presented and the initial variables minimised (Zhu, Z., Li, T., Lu, J., Wang, D. and Yao, C. (2009) Characterization of kaolin flocs formed by polyacrylamide as flocculation aids. Int. J. Miner. Process. 91, 94–99).

9. P210.22: No mention is made of when the anionic or neutral forms of polyacrylamide were used, unless the reader is expected to look up the supplier codes (refer point 4).

10. P210.1 and P211.15 (Sections 5 and 6): Would it not be more appropriate to incorporate the "Jar Tests" section into the "Methods" section?

11. P211.6: "usually" should be qualified.

12. P211.18: "verified in full scale plants". Is supporting information available to substantiate this statement, or is this the data provided in Table 3? If so, would the use of an organic flocculant aid in the Clariflocculator (gamma = 0.56) not complement the jar tests (i.e. support the results by highlighting diminished effect at gamma < 1 at full scale)?

13. P211.21-22: ". . .changes in the content of anion of added coagulant". It is unclear as to what exactly is being quantified. Do the anions of the primary coagulants and cations of the flocculant refer to the counterions, i.e. chloride and sulphate and presumably sodium for the polyacrylamide? If the metal itself was the analyte (Fe, Al), then how was polymeric coagulant (CPE) carryover determined? More details regarding the photo-colorimetric method should also be provided.

14. Comment: P211.26: The results would be strengthened by the inclusion of pertinent analyses such as zeta potential measurements and particle size distributions, rather than relying on tests of aggregation alone (for both jar tests and full-scale evaluation).

15. (a) P212.15: ". . .only the results based on turbidity measurements are included. . .". It would appear that no results are included apart from those provided in Figures 1 and

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3. Both of these relate to the use of ferric chloride over a single run, so why include aluminium sulphate and various CPE in the methods? (b) P212.18: “typical results”. Why is only one graph presented in terms of all the jar tests performed and what makes this any different from drawing conclusions based on a single data set?

16. P214.14: “GT > flocculation optimum... OFA has no effect”. Are there results to substantiate this statement?

17. Comment: The discussion from P214.16 to P215.11 is based on findings from previous work pertaining to the merits of high rate clarification technology.

18. P216.10: The sludge recirculation section almost seems to be an afterthought and requires more comprehensive investigation. The conclusion that recirculation of organic flocculant treated sludge is undesirable is based on four jar tests using only a lime and activated silica process. Why were other chemicals not tested in this manner, considering that lime is rather dissimilar to the previously mentioned primary coagulants? Would ferric chloride, aluminium sulphate or CPE sludge not produce different results? As such, the inference that organic flocculant treated sludge is not desirable can only be made in terms of lime and activated silica, under the conditions and restrictions described.

19. P218.8-10: The word “clarity” appears to be used in two different contexts. What is “actual clarity”? Is one visual and the other measured (if so, how)?

20. Table 2: What is the relevance (or value) of including a single THM formation potential?

21. Conclusions: (a) Conclusion 1: Much of the content is discussion and certain parts should be removed in their entirety (e.g. POA definition). (b) Conclusion 2: The statement “... eliminates all known shortcomings” is not only broad but inappropriate. It does not directly relate to findings presented in the paper. (c) Conclusion 4: “inexpensive upgrading...” cannot be concluded from the paper’s contents. (d) Conclusion

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5: The body text refers to an upflow velocity of 15.5 m/h (P218.24), whereas the conclusion is based on a reference to previous work (P218.20). (e) Conclusion 7: This conclusion is not general but rather specific to the lime and activated silica used in the experiment. In addition, the statement “impairment is proportional to OFA dosage” is new.

Technical Corrections:

(i) The paper should be revised for minor grammatical errors, e.g. P207.26: “up to the flocculation optimum is reached”; P211.19: “such Floccotan”; P218.9: “eventhough”; Table 2: Consistency in capitalisation (Total Hardness. . . Total alkalinity)

(ii) The references are wholly inadequate, which may be rectified by qualifying the “common knowledge” statements and several other assertions, e.g. P207.13

(iii) P208.9: The first figure referenced is Figure 2.

(iv) Figure 4: Just an observation, why “right to left”?

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