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Drinking Water Engineering and Science Discussions

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Interactive Comment

Interactive comment on "Accumulation and modeling of particles in drinking water pipe fittings" *by* K. Neilands et al.

Anonymous Referee #1

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1. Does the paper address relevant scientific questions within the scope of DWES? Definitely.

2. Does the paper present novel concepts, ideas, tools, or data? Yes.

3. Are substantial conclusions reached? Not entirely.

4. Are the scientific methods and assumptions valid and clearly outlined? Not entirely.

5. Are the results sufficient to support the interpretations and conclusions? Yes.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Good description of the relevant fieldwork but the data analysis method could be made clearer.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? This has been done very well.

8. Does the title clearly reflect the contents of the paper? A good title.

9. Does the abstract provide a concise and complete summary? Yes.

10. Is the overall presentation well structured and clear? Sometimes confusing.

11. Is the language fluent and precise? It is sometimes confusing and would benefit from proofreading by someone with a strong grasp of English.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? There are a number of errors and inconsistencies (see below).

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? See below.

14. Are the number and quality of references appropriate? Yes.

15. Is the amount and quality of supplementary material appropriate? The paper would benefit from 1-2 additional examples of how J values are calculated.

Key points:

- An interesting and important issue has been investigated

- The failing of previous discolouration studies to explain how much material accumulates in fittings is well presented. This 'motivation section' includes many relevant references.

- The explanation of the PODDS model (concepts, assumptions, formulas, variables, units) could be expressed more concisely and more consistently.

- The definition of J values and the methods for calculating J values and mobilised material masses are not clear. I don't presently understand whether the turbidity curves can be repeatedly analysed in an automatable way to produce J values. A flow chart

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could help here.

- Tests for correlations and for measures of fit need to be explained and quantified if possible.

- The grammar, spelling and units used in the paper need thoroughly checking.

Ideas for improvement:

As someone with an interest in this research I am personally interested in the following questions:

- What proportion of anomalous turbidity spikes can be associated with the locations of pipe fittings?

- Can the above figure be broken down by fitting type?

Specific comments:

140:5: 0.29kg of material should be quantified w.r.t. the total amount mobilised.

140:21: 'Ryan' incorrectly spelt

140:24: What does 'ud' mean?

141:4: 'precipitated'? Discussing particle deposition, which is unlikely to be solely due to precipitation.

141:2-10: Why mention that more particulate matter accumulated on the wall of the PVC pipe than the lined Fe pipe? If the inclusion of this result can be justified can it also be expressed quantitively.

141:6: Would benefit from rewording. If you want to make the point that particles don't seem to settle in distribution systems under their own weight you could reference a) the section in Boxall et al. (2001) that mentions settling velocities and/or b) the end of section 2.1 in van Thienen et al. (2011).

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141:13: ’SIMDEUM’, not ’SIDMEUM’

141:20: Which van Thienen et al. paper? Two were published in 2011. Are you referring to Floris & van Thienen (2011)? The Floris and van Thienen paper is currently under review. Note that the densities of the particles used in the described experiment are comparable to those in real distribution systems but the diameters are far larger than is typical; the effects of turbophoresis and the Saffman and Magnus forces are likely to be far more significant in that experiment than in reality. van Thienen et al. (2011) noted that the effects of turbophoresis and the Saffman force are unlikely to be particularly significant in distribution systems and the Magnus force is even less likely to have an effect.

141:28: Do you mean ’material accumulated within a wash-out or hydrant body’ during a flush or simply material that was mobilised from along the entire pipe length during the first pipe turnover during a flush?

142:2: Not sure if the term ’Cohesive Theory’ has been used before in the literature. Might want to use the term ’cohesive transport model’ instead as that appeared in Boxall and Saul (2005).

142:3: ’both the accumulation and erosion of particles have been combined’ – needs rewording. Could say ’With the PODDS model discolouration material is assumed to be homogenously distributed around the pipe’s circumference in cohesive layers of particulate matter. The layer strength is a function of the the maximum daily shear stress. Material erosion and regeneration processes can be modelled through calibration.’

142:8: ’occurs’, not ’occurrs’

142:9: ’are conditioned’, not ’is conditioned’

142:9: ’the background’, not ’background’

142:11: ’the treatment’, not ’treatment’

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142:14: Also worth referencing Vreeburg et al. (2008)

142:28: A very good point!

142:29: 't-piece', not 't-bend'

143:3: 'spikes', not 'pikes'

143:3: 'corresponded' a better choice of word than 'fitted'

143:8: PODDS model emphasizes relationship between applied (flushing) shear stress (a function of more than just bulk velocity) and the rate of change of a) turbidity potential and b) supply of material to the bulk water. It might therefore be appropriate to work with shear stresses rather than velocities in this paper if an objective is to extend the PODDS model.

143:9: 'online measurement timesheet' - needs rewording

143:19: Oxidation using air? Not chlorine, ozone or UV?

143:19: 700mˆ3/day could be better expressed as a setpoint concentration.

143:24: Vreeburg et al. (2008) found that filter backwashing correlated with turbidity spikes.

145:3: Demand figure seems low: in the UK hydraulic modellers typically estimate the per-capita consumption to be 140L/person/day, which would give a total of 1260mˆ3/day for 9000 inhabitants.

145:5: 'There were two', not 'there where two'

145:25: Equation incorrect (check the units). Should be L=Q/A * t, not L=A/Q * t

146:7: 'spike', not 'pike'

146:8: Mean or median?

146:5: Need to state that this was done for every flushed pipe section. Would be

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clearer if “(30 NTU and 26 NTU)” and “(Fig. 4)” were combined e.g. “For example, the locations in the network corresponding to the spikes of 30NTU and 26NTU in Fig. 4 were found using Eq. 1 and an estimate of flow”.

146:10: It is not clear whether >1 J coefficient is found for profiles containing >1 sharp turbidity spike.

146:10: If there are no fittings along a pipe length then the peak turbidity turbidity curve corresponds to the turnover time (logarithmic rise up to the turnover time then exponential decay afterwards). It should be noted that this peak needs to be distinguished from spikes corresponding to material mobilised from fittings and fixtures. This could be done either visually or using the turnover time.

146:13-15: Needs rephrasing. Why is lots of data required?

146:20: Remove ’it means that’

146:23: More common to use S_0 (hydraulic gradient) than delta H (headloss over length of pipe) in this equation

146:24: Shear stress typically expressed in Pa or Nmˆ-2 (equivalent units).

147:5: Remove ’wetted’: should only be used as a prefix to ’perimiter’.

147:8-10: The use of C is confusing: C is used in the PODDS model to represent turbidity potential i.e. the amount of material bound to the pipe wall, not the turbidity of the bulk water.

147:10-16: The use of R is confusing: R is used in the PODDS model to represent the rate of material supply from the pipe wall to the bulk water when the applied (flushing) shear stress exceeds the material layer strength. R=P(tau_a – tau_c)ˆn. The units of R are NTUm sˆ-1.

147:15: The use of n is confusing: n is used in the PODDS model as described above.

147:16: The definition /equation for Turb_total should feature in a separate sentence. With the PODDS model the amount of material mobilised per flush is typically quantified by integrating NTU w.r.t time then multiplying by flushign flow (assuming that is constant) to give a value in unist of NTUmˆ3.

147:20: This expression typically features a denominator of flow.

148:3: C should appear after 'turbidity peak' to make the sentence read better. Ideally a different letter should be used to represent turbidity peak. The peak will occur at the turnover time (L/V) if no material is mobilised from fittings).

148:3: Why consider maximum hourly velocities? I don't understand this sentence.

148:8: Where does the gradient and offset terms in this expression come from? If it has been derived using empirical data where is the data and the Rˆ2 value? Why is only one formula presented? If the flushing shear stress, pipe material and diameter differed between flushes then this relationship will be vary between flushes.

148:11: Confusing: the maximum turbidity value(s) per flush can be determined from the turbidity curves alone.

148:11: 'rate' is a better word than 'magnitude'

148:13: Did you investigate whether P and n could/should vary between flushed pipes?

148:18: 'constant flushing flow' and 'constant flushing shear stress'.

148:22-23: Can this statement be quantified statistically e.g. "67% of 45 anomalous turbidity spikes could be attributed to material mobilisation from t-pieces and 23% could be attributed to 90 degree bends".

149:4: NTU_averge: average spelled incorrectly. Term not used above.

149:6: Confused: shear strength does not have units of NTUmˆ3

149:8: Better expressed as an integral w.r.t t. Units problem: the units of the expression

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are NTUkg?

149:9: Was the mass of mobilised material calculated so as to include all mobilised material or only the material mobilised from fixtures and fittings?

149:17: Assumption has previously been stated.

150:2: Were the pipes flushed at night to minimise the error in your flow estimates?

150:12-19: It is difficult for the reader to compare kg and g/mˆ-1. The values should be converted to common units.

150:12-13: Why were the values so much higher than others in the literature (which take into consideration not only the material mobilised from fittings but also from the pipe wall too)? Are you suggesting that much more material accumulated in fittings than along the pipe wall?

150:19: See also (Vreeburg, 2007, pp.51–52)

150:19: 'flushing shear'

150:19-21: How did you test for correlation? Would it make more sense to look at the relationship between the amount of material that was mobilised per fitting and the difference between the maximum daily shear stress and the flushing shear stress?

150:27-151:15: This appears to be an extension to the literature review. What does this section contribute to the discussion section?

151:9-15: Blokker et al think that rate of material accumulation is related to the maximum daily velocity; Boxall et al think that the maximum amount of material that can accumulate and the strength of that material is not a function of maximum daily velocity but maximum daily shear stress. Shear stress is itself a function of not just velocity but also diameter and roughness.

151:16-19: Repeated; already included in section 2.5

152:8-11: As previously stated the Magnus and Saffman forces have limited effects in most drinking water distribution systems. Also, neither explain how material remains attached to the wall.

153:8-13: Could get very different model fit if assume that the first two data points are just outliers. Higher temporal data resolution could have helped here. How did you decide how frequently to sample turbidity? In your method section it said dt varied between 5s to 1min.

153:18-24: Measure of model fit to data should be quantified.

153:27: 'Non-Disclosure Agreement' not 'copyright law'

154:2: Aisopou spelled incorrectly

154:5-6: Yes, these parameters are not constants.

155: Units confusingly differ from those used in PODDS-related papers (tau, R, P, C)

166: What is 'J junct'?

170: No pipe of this length is listed in Table 3

References

Boxall, J., Skipworth, P. & Saul, A., 2001. A novel approach to modelling sediment movement in distribution mains based on particle characteristics. In Water Software Systems: v. 1: Theory and Applications. CCWI2001.

Floris, R. & van Thienen, P., 2011. Experimental investigation of turbulent particle radial transport processes in DWDS using optical tomography. Drinking Water Engineering and Science Discussions, 4(1), pp.61–83.

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Vreeburg, J.H.G. et al., 2008. Impact of particles on sediment accumulation in a drinking water distribution system. Water Research, 42(16), pp.4233–4242.

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