Using Zeta Potential to Optimise Coagulation For a Dirty Water Event

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Introduction

Challenges in Water Treatment
Dirty water events, due to heavy rainfall for example, increase natural organic matter (NOM), turbidity, and color, complicating coagulation and flocculation processes.

Zeta Potential Optimisation
Zeta potential can be used to optimize coagulation for better performance during water treatment. Previous studies have shown that there is an operational range of -10 to +3 mV for coagulation to achieve optimum removal of natural organic matter (NOM) predominately, along with other parameters.

Overall Objective
Optimise the coagulation/flocculation process to maximise NOM and turbidity removal, to inform the effective treatment of future 'dirty water events.

Method

Experimental Plan
The study followed four stages:
(i) raw water characterization of the five samples collected during a dirty water event,
(ii) determination of optimum coagulant (aluminium sulfate (alum), ferric chloride, aluminium chlorohydrate (ACH), and poly aluminium chloride (PACl)) and associated dose,
(iii) determination of optimum flocculant (poly 905, poly 4190, polyDADMAC and LT22s) and dose,
(iv) application of the optimum coagulant and flocculant to the other water samples.

Jar Tests
Jar tests were performed at three different pHs for each coagulant. Zeta potential was used to optimise dose for each of the four coagulants and three doses were chosen within optimal zeta-potential range (-10 to +3 mV), based on previous studies on NOM coagulation.

Analytical Techniques
For all jar tests, the dissolved organic carbon (DOC), UV254, true colour and turbidity were measured. All experiments were compared to the existing treatment protocol of alum and poly905.

Results

Raw Water Characterisation

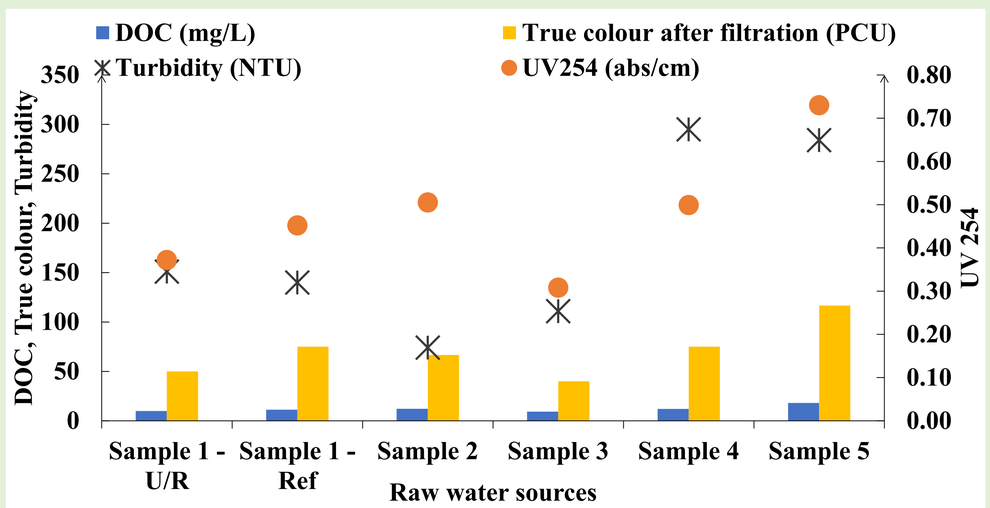

Figure 1: Dissolved organic carbon, true colour, turbidity and UV absorption at 254nm for all raw water samples. U/F = unrefrigerated since collection, Ref = refrigerated.

Jar Test Results – Optimised Regimes (other samples)

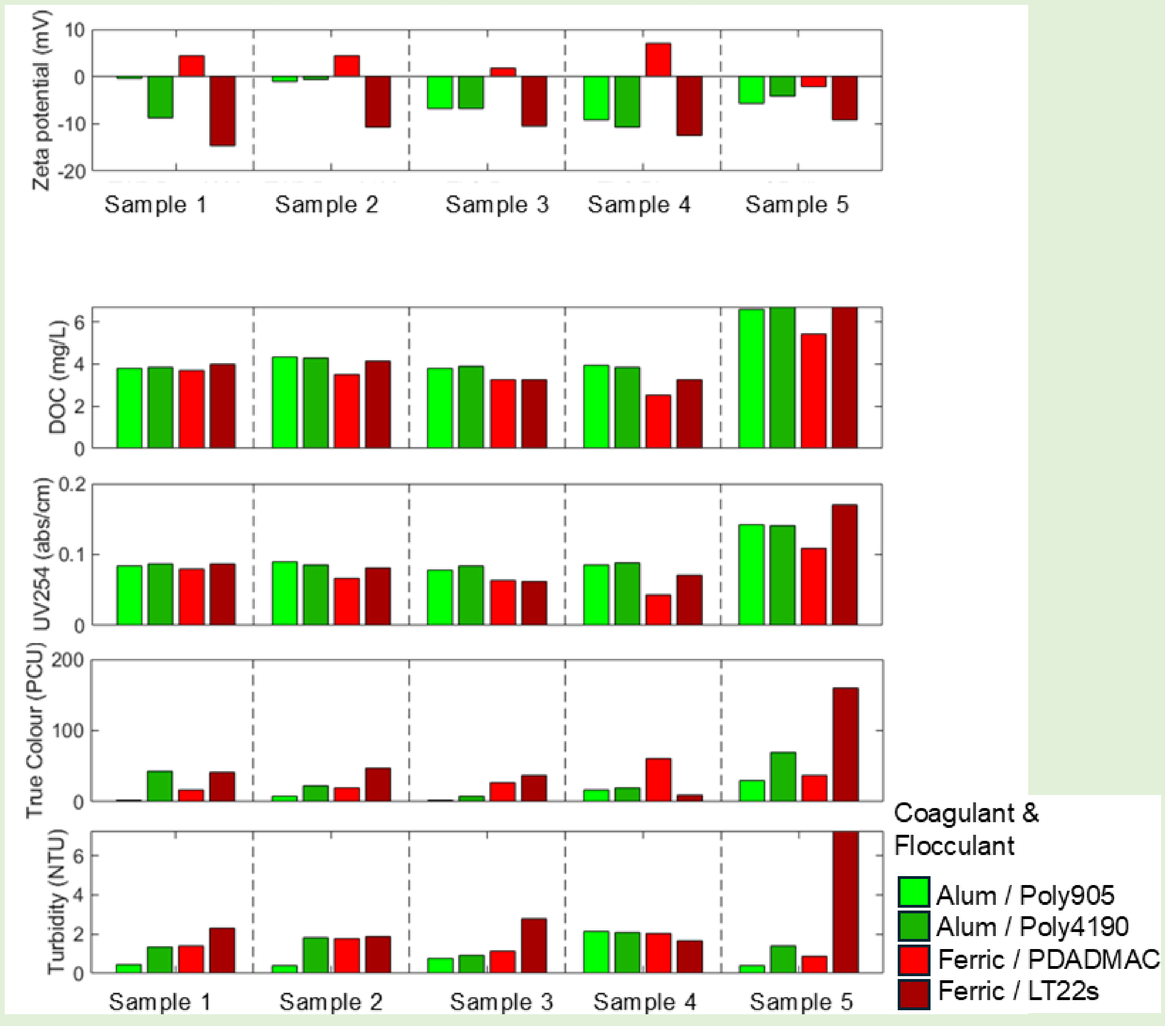

Figure 3: Coagulation-flocculation jar tests results for zeta potential. DOC, UV254, true colour, and turbidity for all other raw water samples.

- For all samples DOC removal ranged from 58.1 to 78.8%, UV254 removal 72.7 to 91.4%, and turbidity removal 97.4 to 99.9%.
- Application of ferric and LT22s resulted in an increase in true colour for Sample 5, while for the other jar tests removal ranged from 6.3 to 96.7%.
- The combination of ferric and PDADMAC achieved the optimal removal for DOC and UV254.
- While alum with poly 905 achieved the best removal for true colour and turbidity.

Jar Test Results – Coagulant only (Sample 1 unrefrigerated)

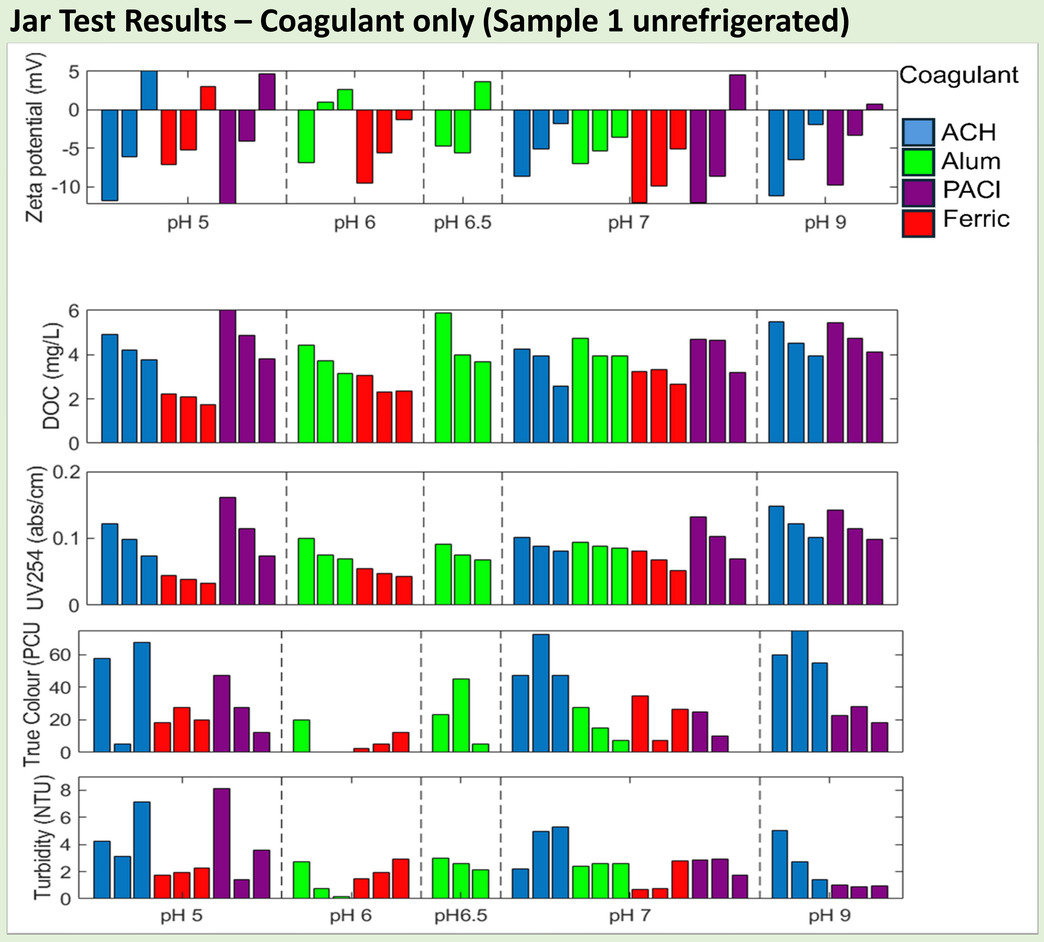

Figure 2: Coagulant jar test results for zeta potential, DOC, UV254, true colour, and turbidity.

- The doses based on zeta potential were higher than those based on WTC-Coag.
- Ferric achieved the optimum removal for all parameters.
- The two polymeric coagulants tended to have reduced performance compared to alum and ferric.
- For subsequent tests. ferric at pH was selected as the optimum regime.
- For the currently used coagulant, alum, pH 6 gave the best performance.

Conclusions

- Zeta-potential was a useful parameter to use to optimise coagulant dose, especially with the changing water characteristics of the samples and variety of pH values tested.
- For these raw water samples, with high DOC and turbidity values, keeping zeta potential in the range 0 to +3 mV facilitated consistent removal of these parameters.
- For alum, pH 6 overall gave better performance than pH of 6.5 (current protocol) with the coagulant only jar tests.
- The optimal alum doses, based on zeta-potential and subsequent performance, were higher than normally used (Avg. WTC-Coag %SP 130).
- The existing coagulant and flocculant combination (alum & Poly905) achieved the highest removal of true colour and turbidity.
- The alternative coagulant and flocculant combination of ferric dosed with PDADMAC (1 mg/L) achieved the highest DOC and UV254 removal.

Acknowledgements

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