



**Ferrate(VI) as a New Water Treatment Agent
for Wastewater Reuse**

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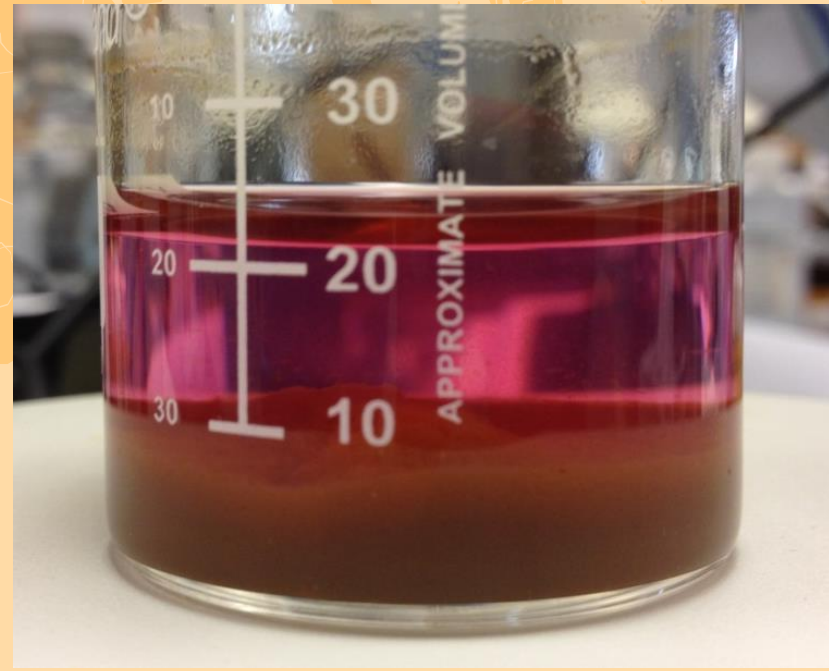
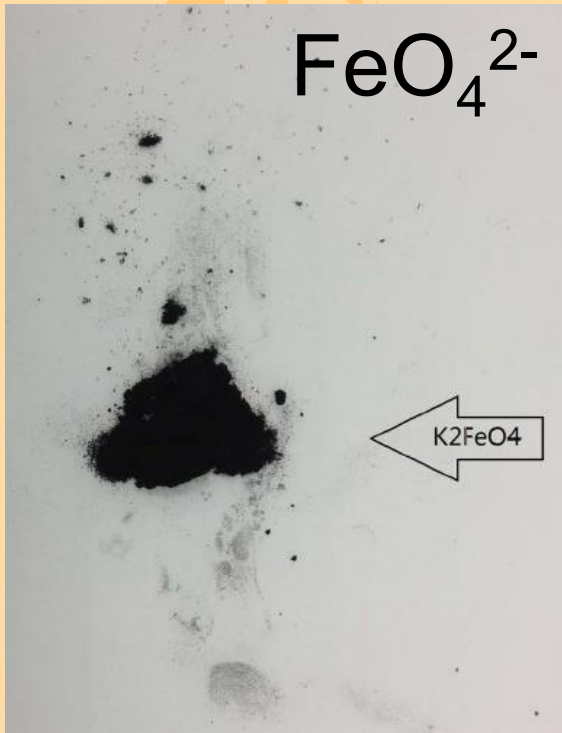
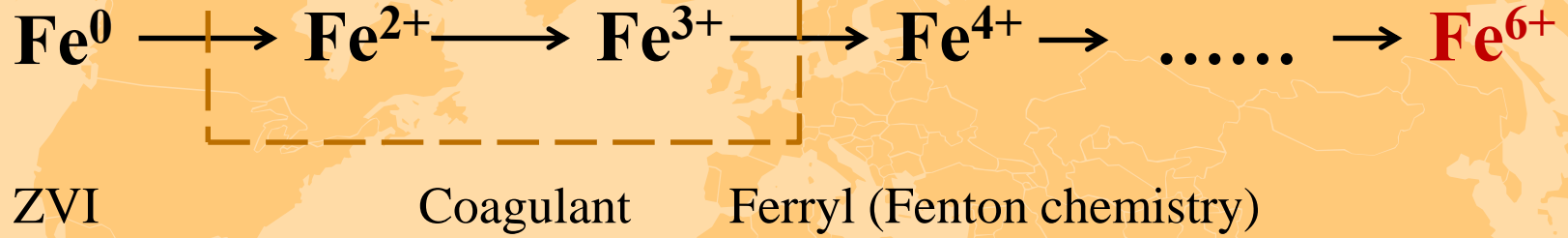
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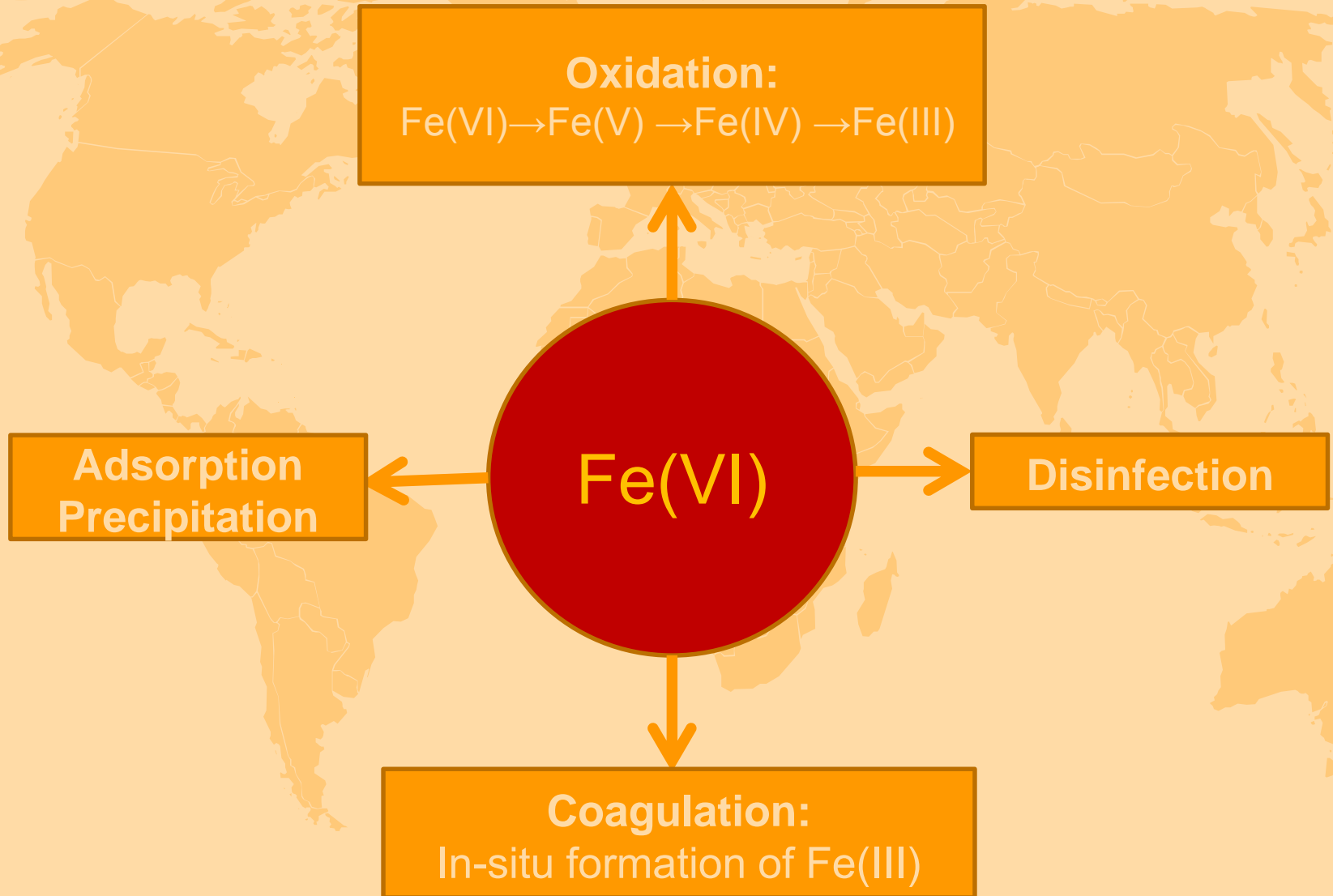


Iron with Variable Valences





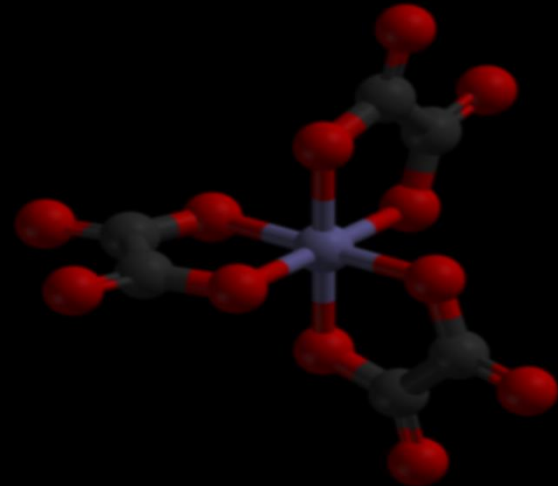
How does Fe(VI) work?





Green Treatment Reagent

- One chemical, multiple functions;
- Non-toxic final products;
- No production of DBPs





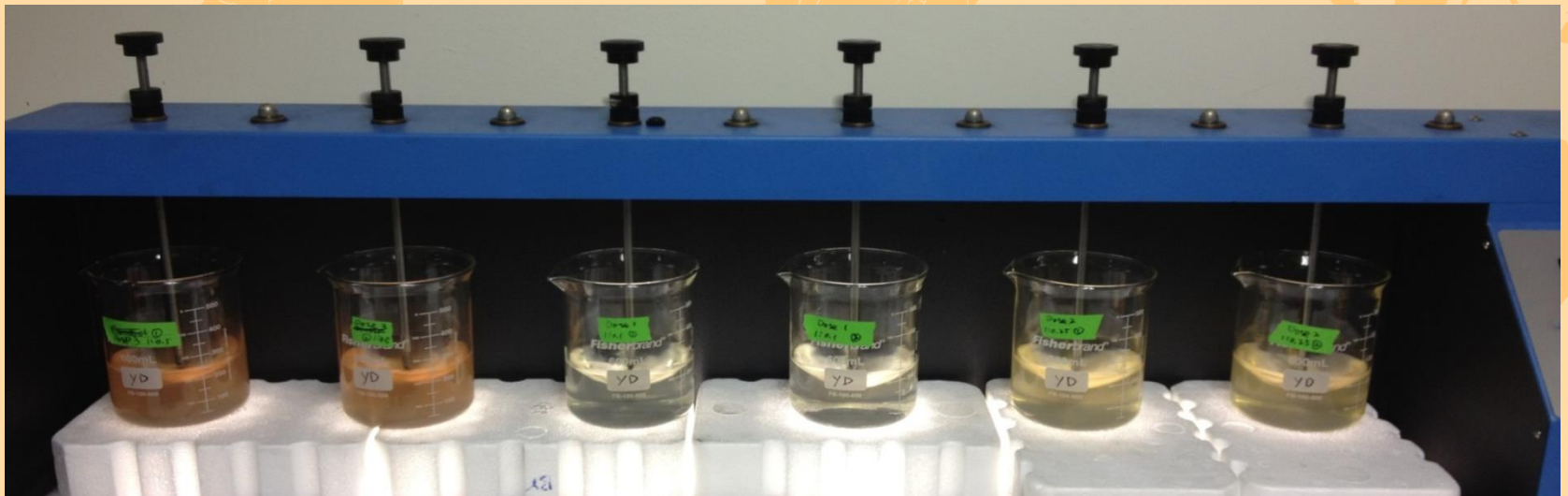
Objective

- *To evaluate ferrate(VI) for advance treatment of secondary effluent*
- Specifically,
 - Fe(VI) decay in secondary effluent
 - Characterization of Fe(VI)-induced particles
 - Removal - effluent organic matters (EfOM)
 - Removal – nutrients
 - Removal – emerging contaminants



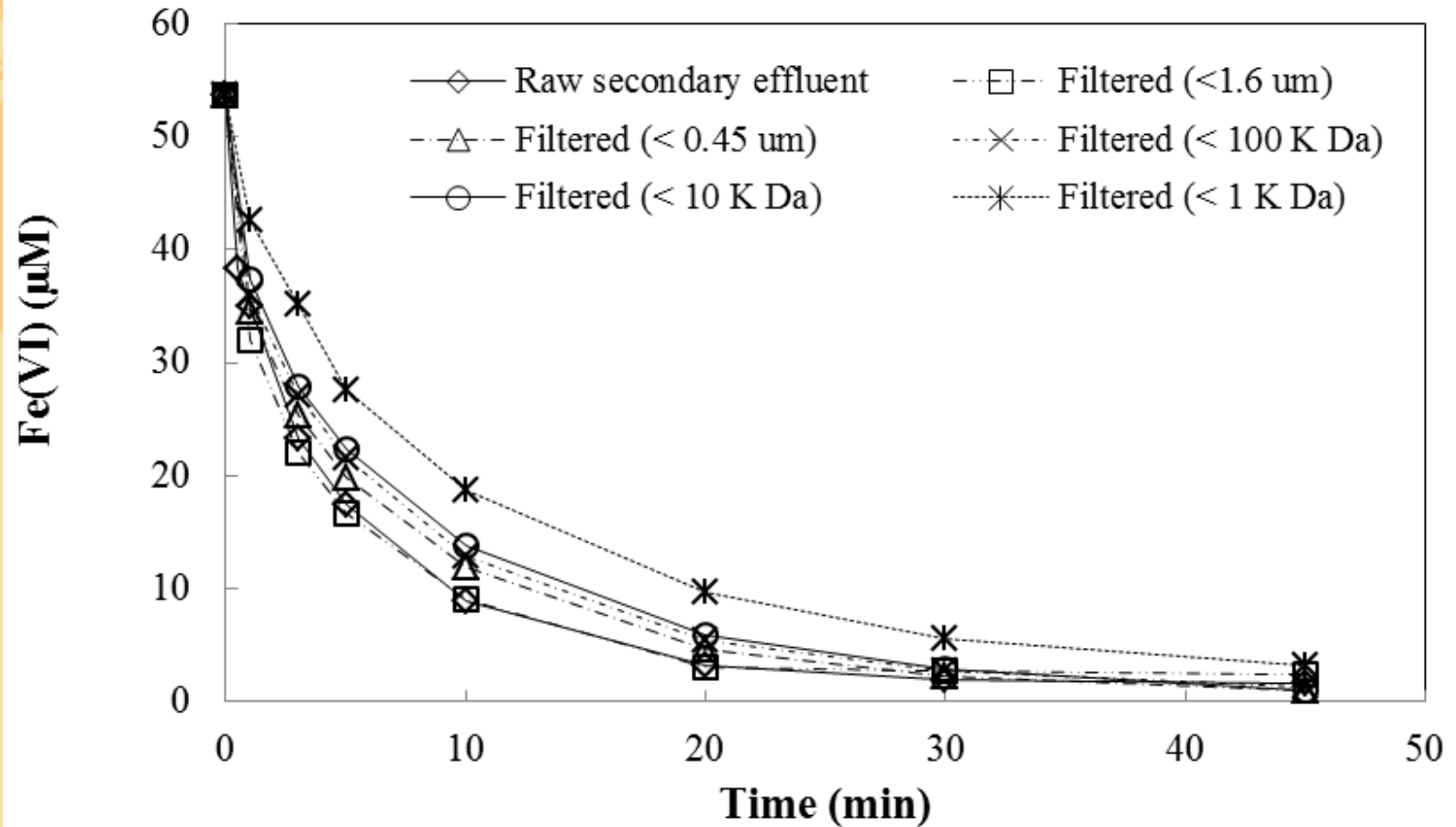
Experimental

- Jar tests
- Secondary effluent was collected from a local WWTP
- In a typical run, rapid mixing (150 rpm) followed by slow mixing (30 rpm)





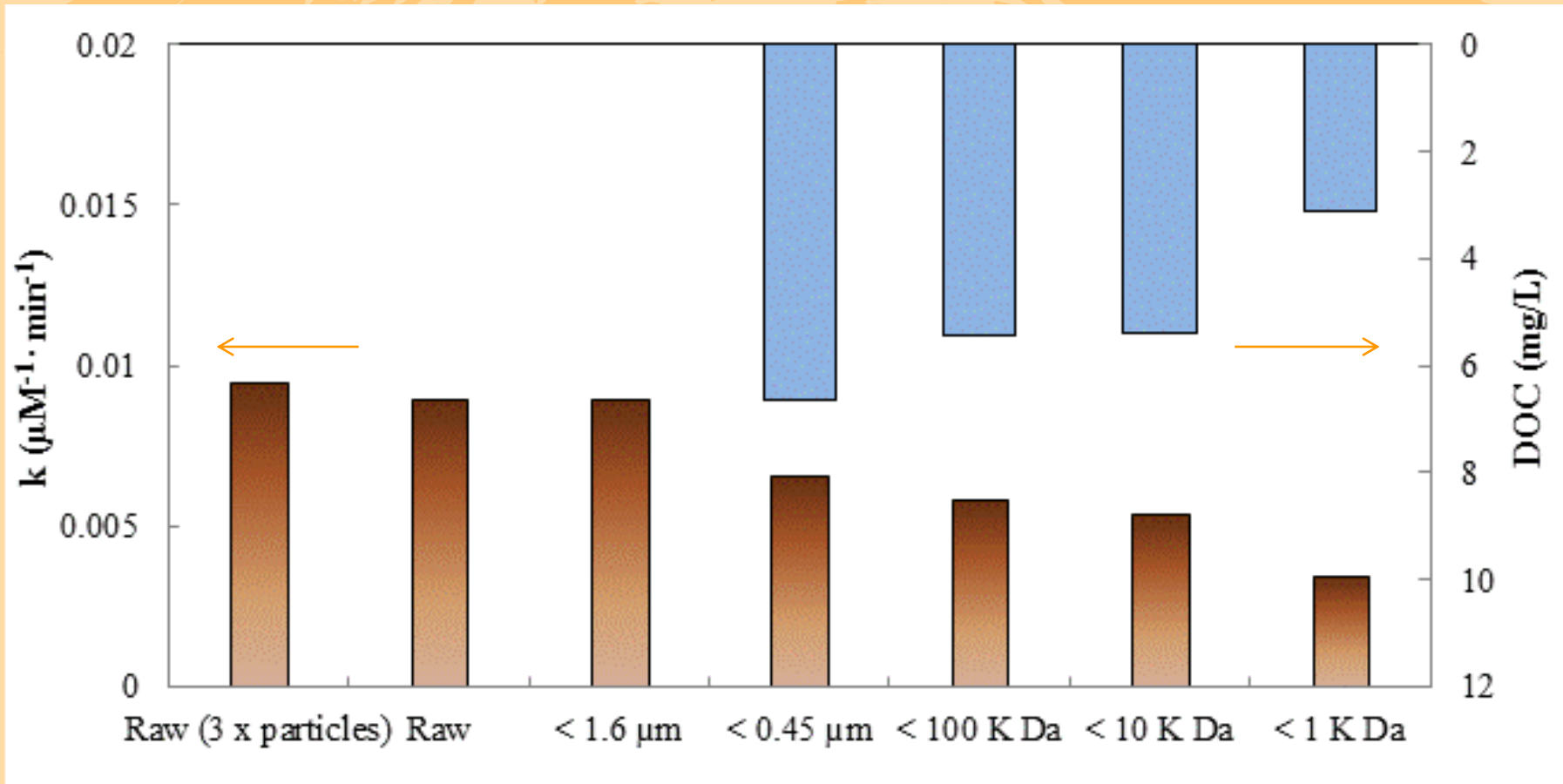
Fe(VI) Decay in Secondary Effluent



(Fe(VI) = 54 µM (3 mg/L Fe), pH = 8.5)



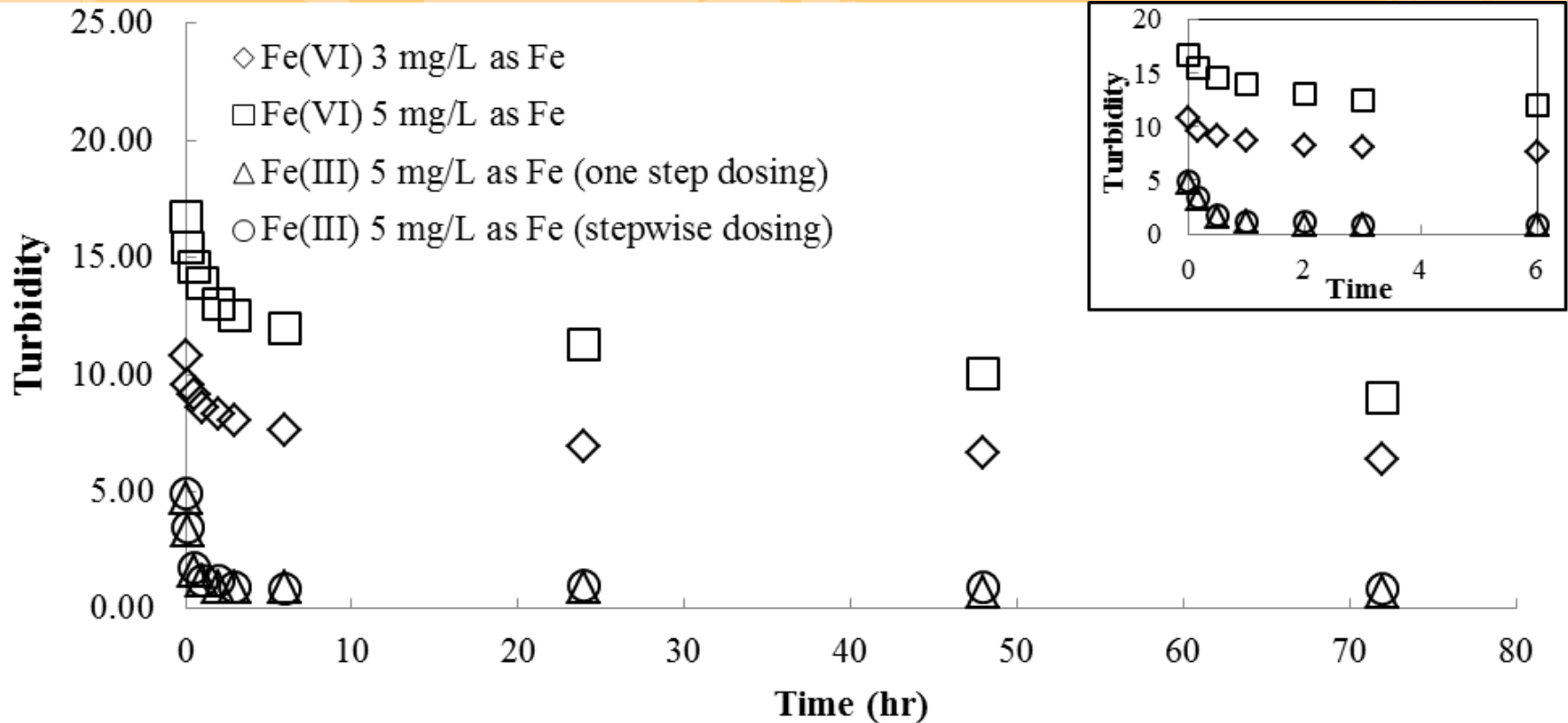
Fe(VI) Decay in Secondary Effluent



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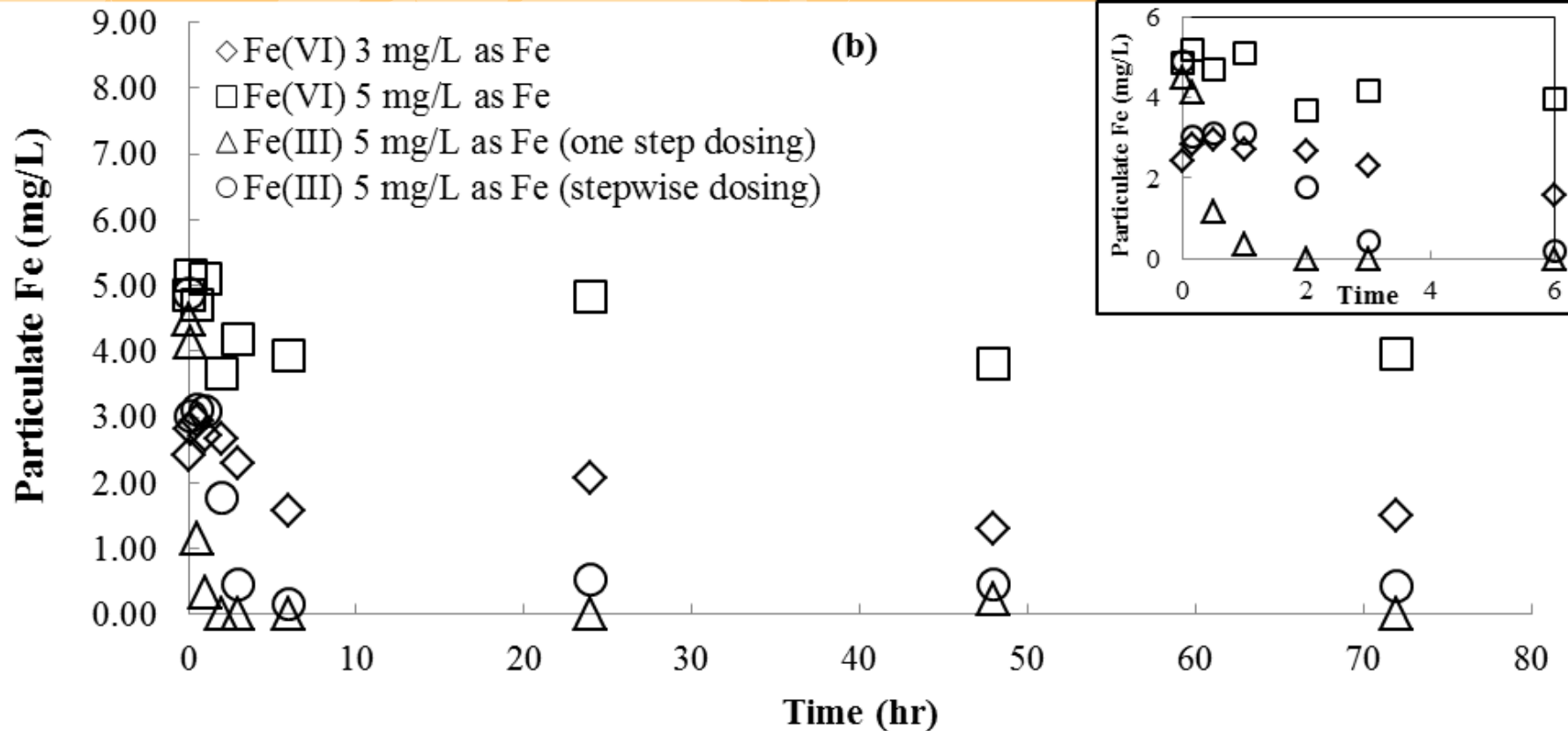
Settleability of Fe(VI)-induced Particles



(pH = 8.5)



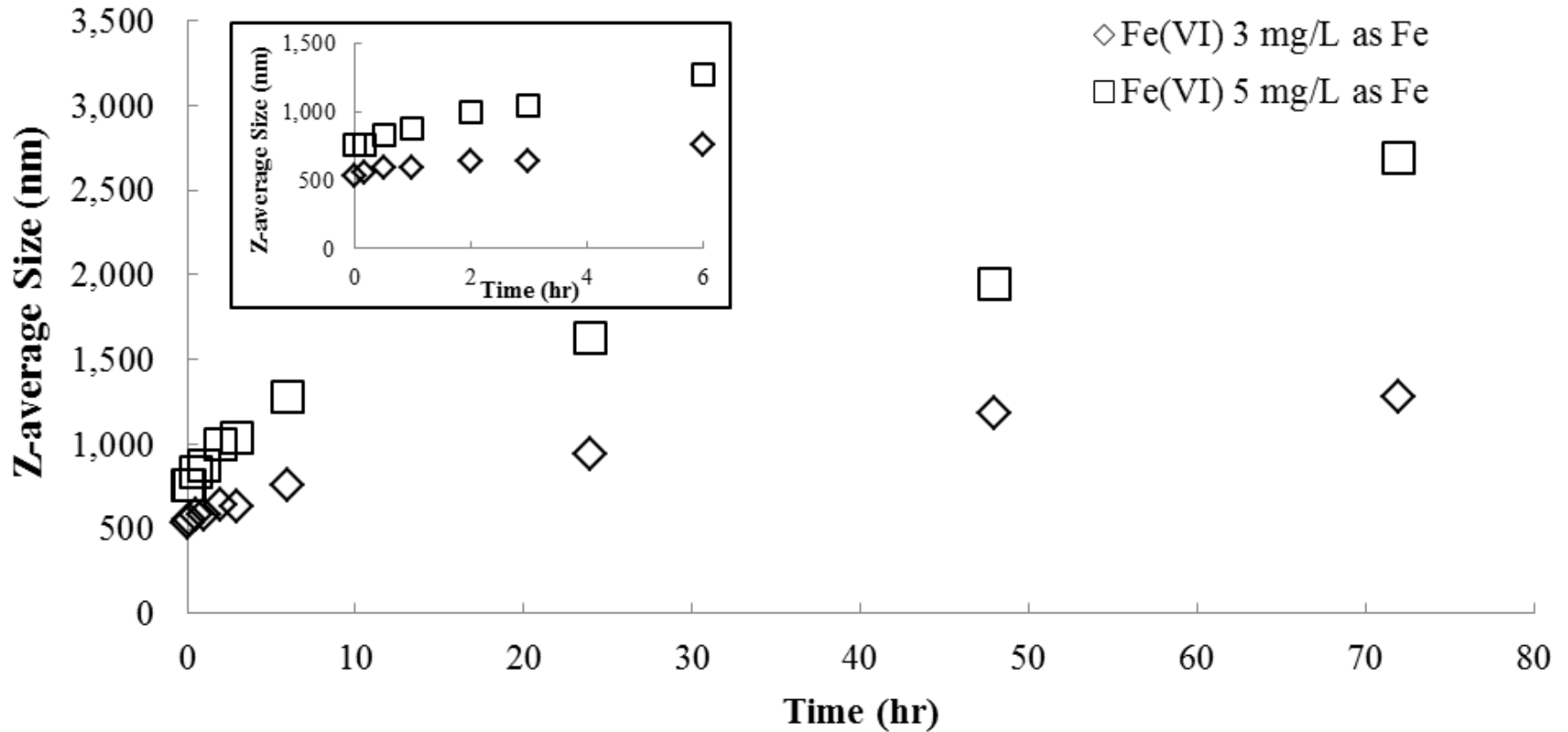
Settleability of Fe(VI)-induced Particles



(pH = 8.5)



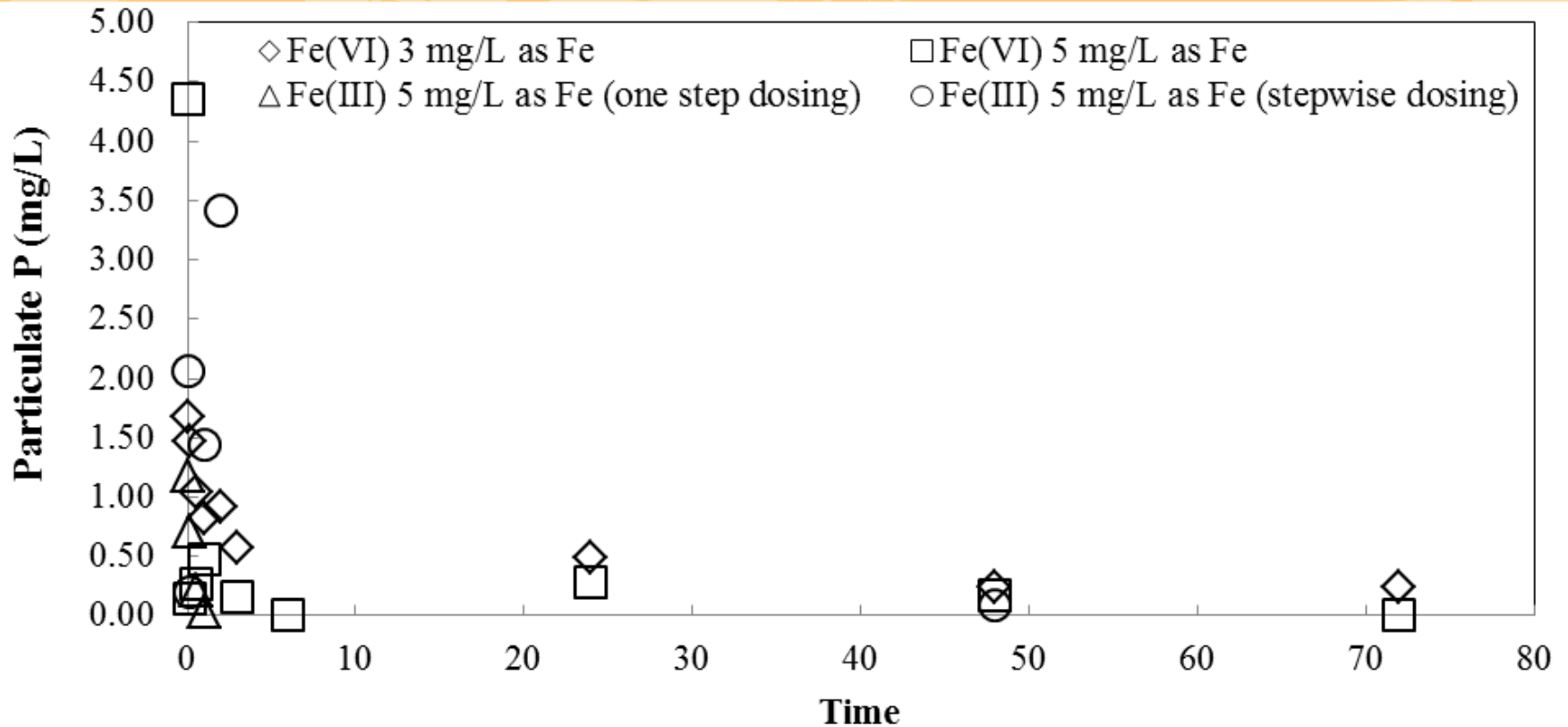
Z-average size of Suspended Fe(VI)-induced Particles



(pH = 8.5)



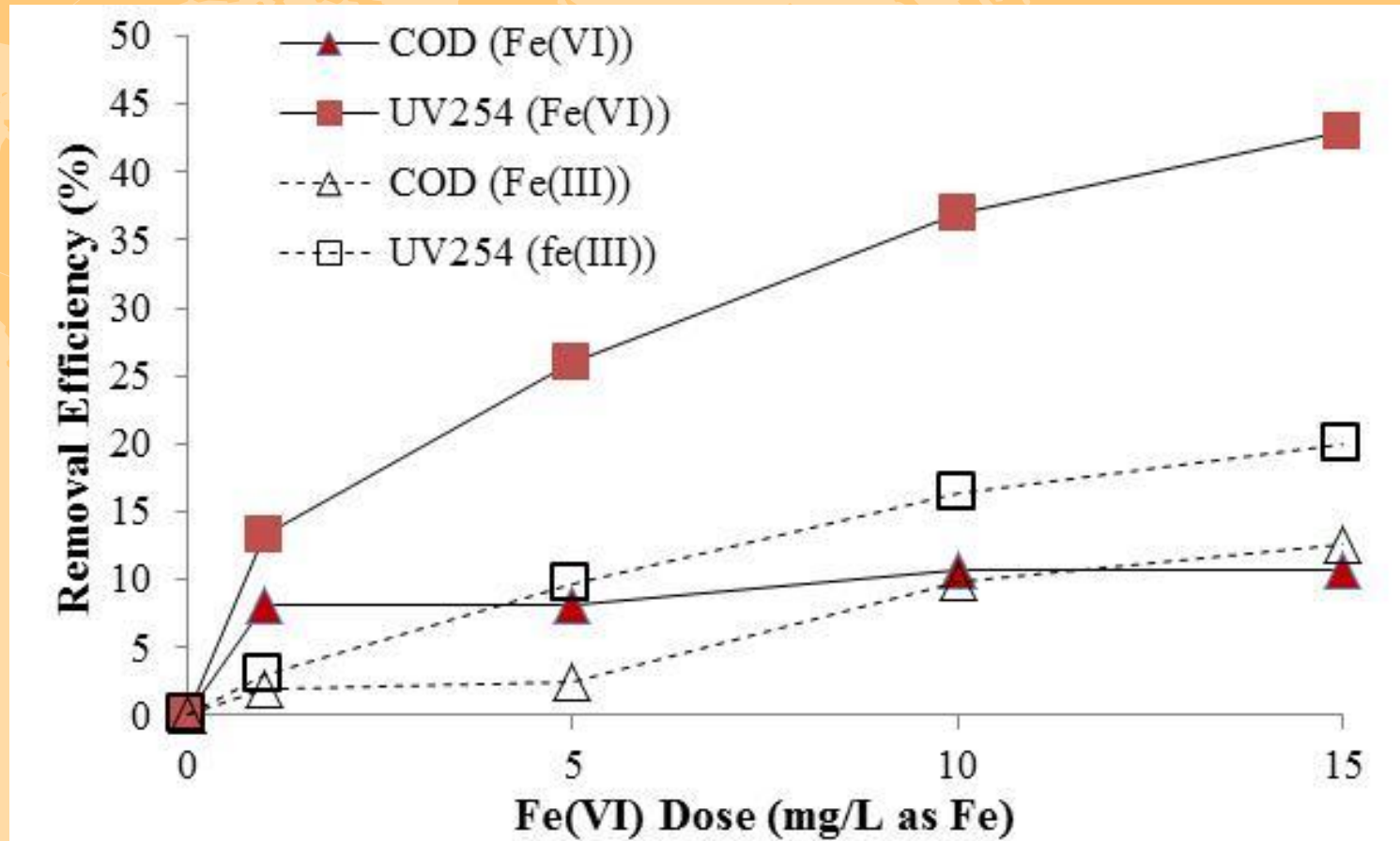
Suspended Particulate P



(pH = 8.5)



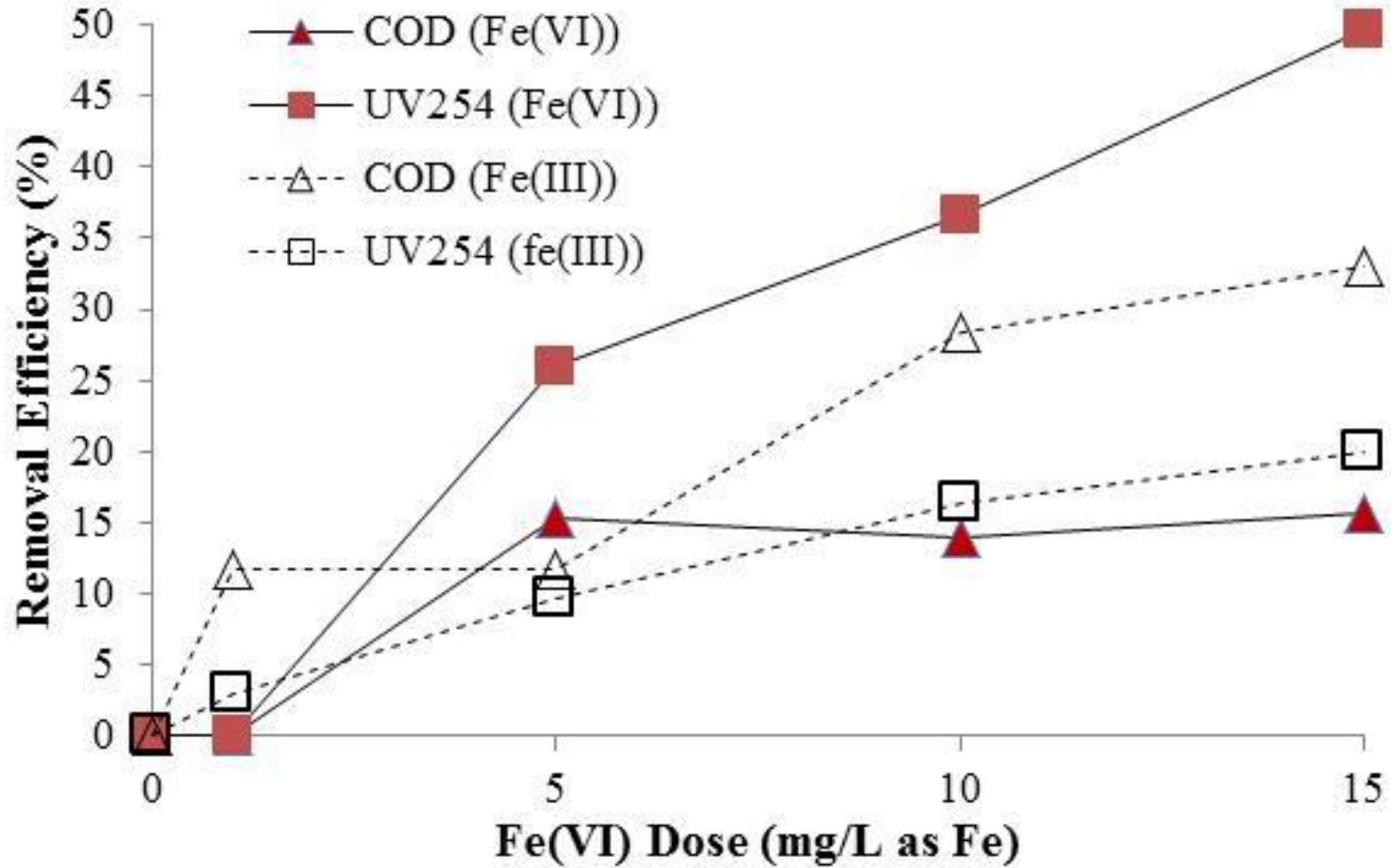
EfOM (no pH control)



(COD₀ = 32 mg/L; Initial UV₂₅₄ = 0.135; initial pH = 8.5)



EfOM (pH 5.0)

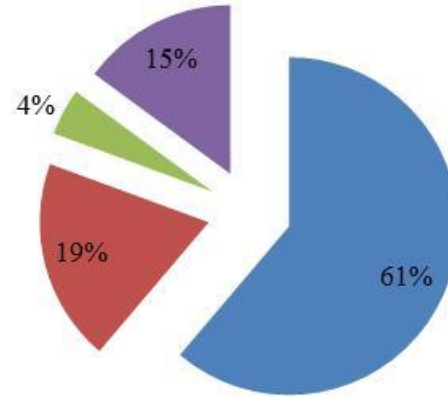


($COD_0 = 33$ mg/L; Initial $UV_{254} = 0.139$)

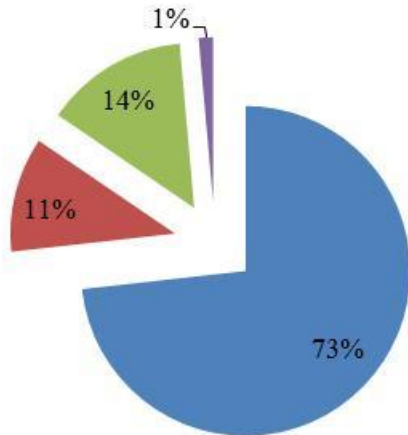


MW Fractions (no pH control)

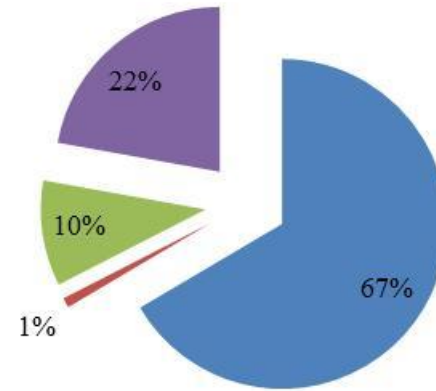
- < 1k Da
- 1-10 k Da
- 10-100 k Da
- > 100 k Da



Untreated
(UV₂₅₄ = 0.134)



Fe(VI) (15 mg/L)
(UV₂₅₄ = 0.071)

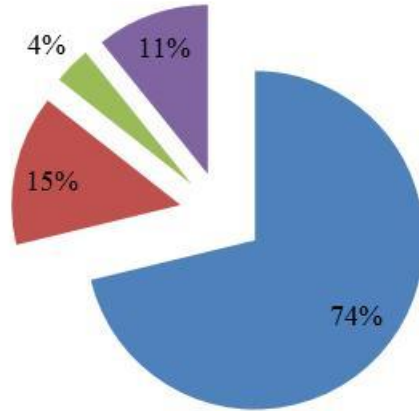


Fe(III) (15 mg/L)
(UV₂₅₄ = 0.108)

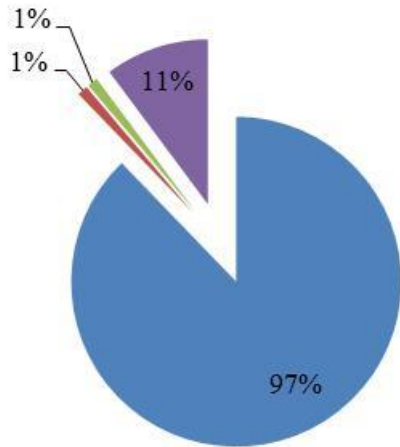


MW fractions (pH 5.0)

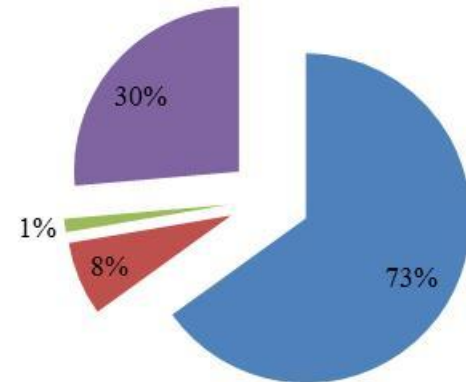
- < 1k Da
- 1-10 k Da
- 10-100 k Da
- > 100 k Da



Untreated
(UV₂₅₄ = 0.139)



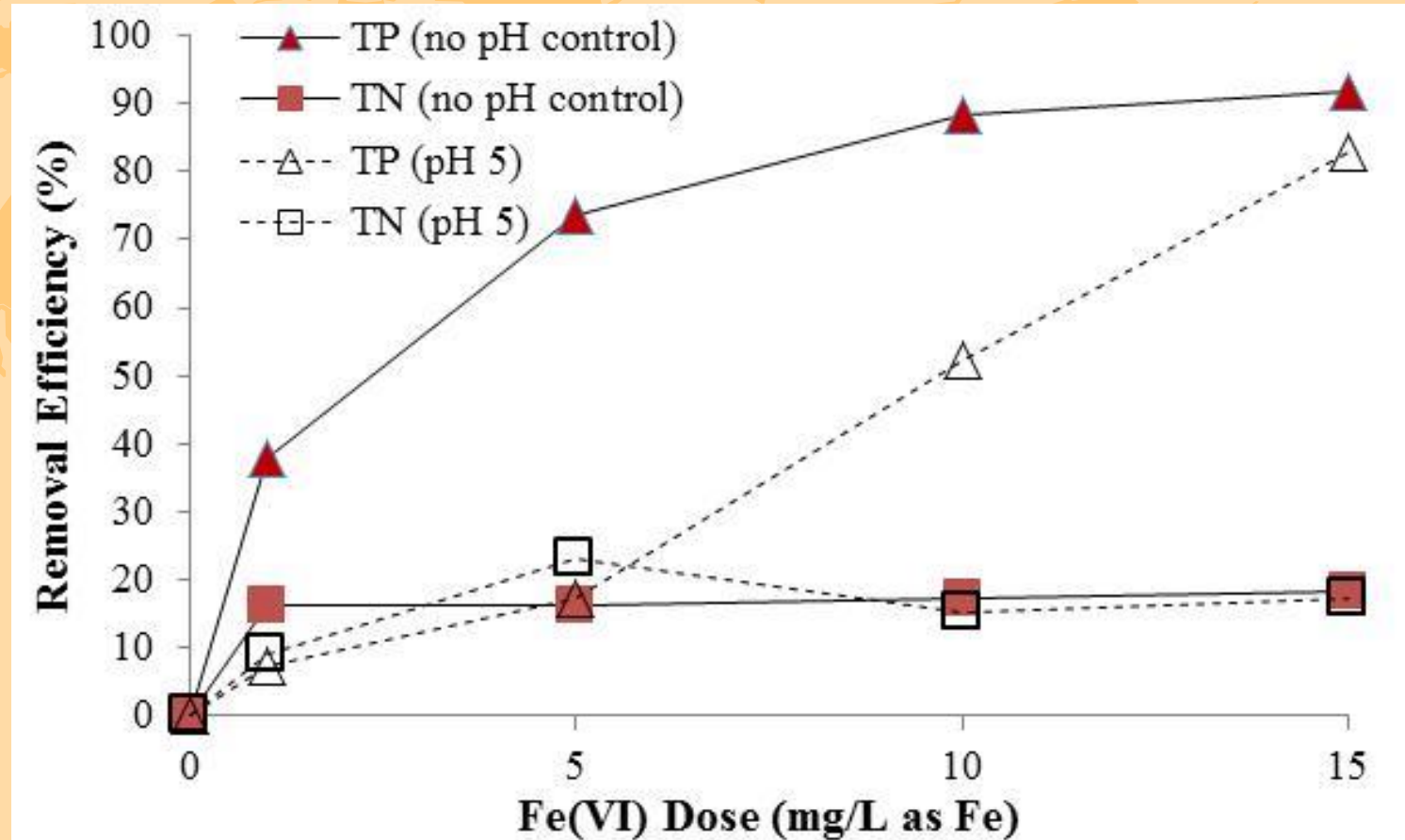
Fe(VI) (15 mg/L)
(UV₂₅₄ = 0.079)



Fe(III) (15 mg/L)
(UV₂₅₄ = 0.110)



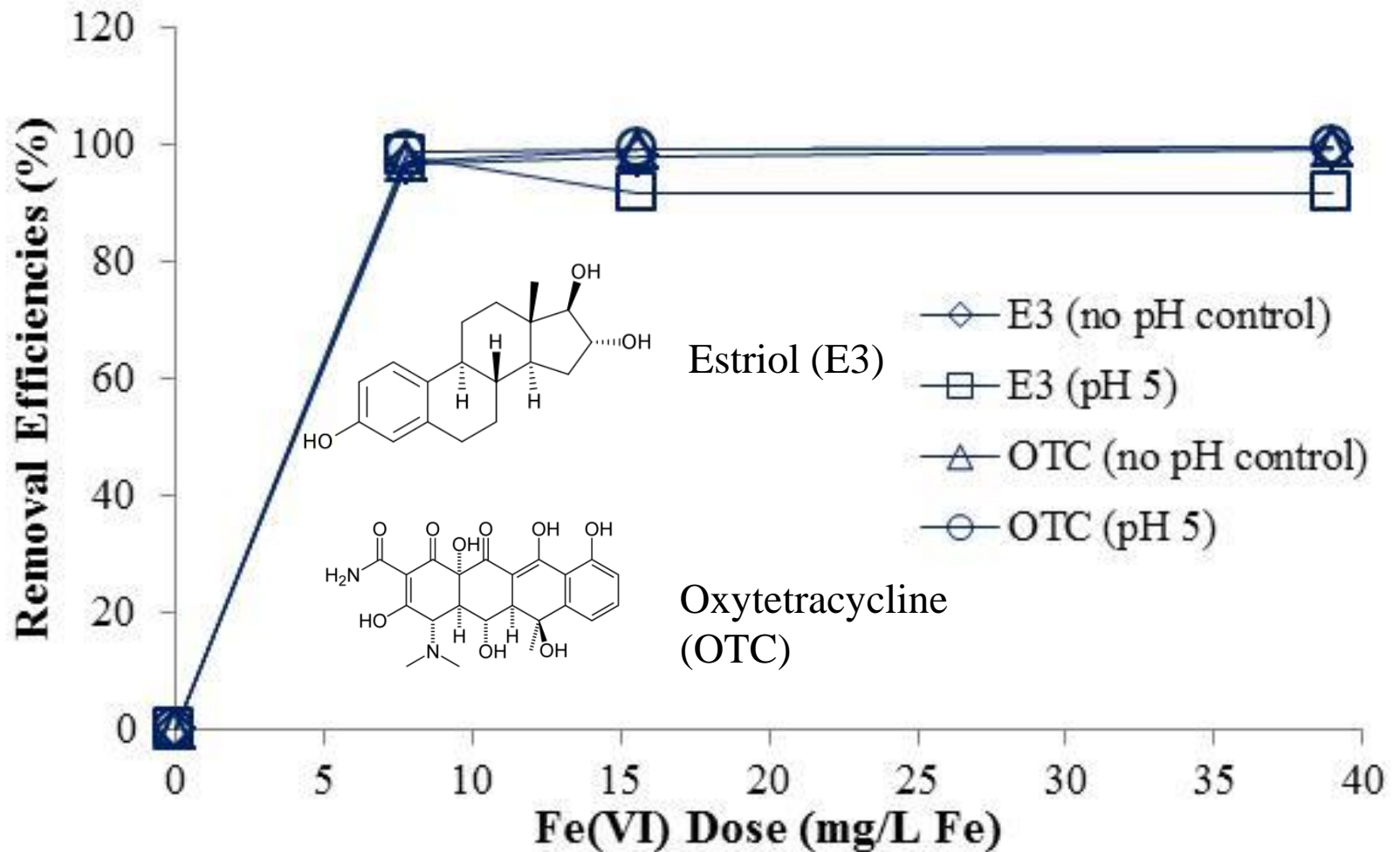
Nutrient



($TP_0 = 4.68$ mg/L; $TN_0 = 19.6$ mg/L)



Emerging contaminants





Conclusion

- Fe(VI) decay in secondary effluent is a 2nd order reaction;
- Suspended particles and EfOM enhanced Fe(VI) decay (the former might be due to surface catalysis, while the latter is due to its reaction with Fe(VI))



Conclusion

- After Fe(VI) oxidation, Fe(VI)-induced particles were mostly suspended, increasing water turbidity. These particles ought to be removed in the following treatment
- Fe(IV) preferentially reduced UV254, instead of COD
- TP and emerging contaminants were readily removed



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Any Question?

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