Effect of Sodium Silicates on the Properties of Iron Particles and Suspensions to Control “Red Water” in a Water Distribution System

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tables and figures


text

Introduction & Significance

- Research is needed to better understand the relationship between silicate dose (mg SiO\textsubscript{2}/L), and properties of iron particles and suspensions as a function of water chemistry.
- In addition to iron in source water, the corrosion of iron-based pipes and plumbing materials in drinking water distribution systems can produce iron precipitates.\textsuperscript{1,2,3}
- Iron particles in drinking water can lead to “red” water, and taste and odor complaints.\textsuperscript{4,5}
- Sodium silicates have reported corrosion control properties and have an ability to affect the optical properties of iron particles and associated suspensions.\textsuperscript{4,5,6}

Results

Controlled Batch Tests:

- Dissolved inorganic carbon (DIC) varied with sodium bicarbonate
- Silicate adjusted using Na\textsuperscript{+} Sodium silicate (PQ Corp. Chicago)
- Iron stock solution (ferrous sulfate heptahydrate) added to prepared water & stirred for 20 minutes
- pH controlled using automatic titrator (0.6M HCl & 0.6M NaOH)
- Sequence of iron and silicate addition varied

When sodium silicate was added after iron was oxidized, there was no apparent impact on iron suspension turbidity (Figure 1) and color, and particle size even though zeta potential decreased. Silicate added before iron was oxidized had a very large impact on reducing iron suspension turbidity (Figure 1) and color, and particle size. The following discussions will pertain to the case of pre-silicate addition.

- Sodium silicate reduced the color and turbidity of iron suspensions (Figure 2).
- At a given DIC, increase in silicate dose resulted in a decrease in particle size and reduction in particle flocculation, and more stable suspensions (Table 1).
- Sodium silicate decreased zeta potential (particles became more negative) even at low doses (Figure 3). This suggests that a charge-related particle dispersion may be a mechanism for the observed visual properties of the iron particle suspensions.

Results (Cont.)

- DIC did not have a large impact on the properties of the iron suspensions in the presence of silicate.
- Cases in which there was more than 15 mg SiO\textsubscript{2}/L the suspension particle size did not change and remained stable (no visible settling of particles) over a 21 day period. (Figure 5)
- Lower iron dosages indicate that there may be an optimum silicate dosage depending on the iron concentration.

Conclusions

- Silicate greatly reduced iron particle size and charge, and associated suspension turbidity, color and stability (long-term as well) provided silicate was added before the iron was oxidized.
- A surface charge related mechanism is likely responsible for the observed effects of silicate on iron suspensions.
- This information can be used to provide assistance to distribution systems with “red” or turbid distribution system drinking water.
- Jar testing as used in this work may be useful to utility operators in selecting an appropriate site-specific dose.
- Research considering the application of silicate in full-scale water distribution systems with iron corrosion issues would be useful.
- Parallel studies could be performed on the impact of sodium silicate for different metal particles such as manganese, lead, and copper.

Collaborators

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References