

Precipitation Modeling Approach

Evolve the distribution moments

Number of particles (0th moment) $\rightarrow \frac{dN}{dt} = \dot{N} = k_{nuc} \exp\left(-\frac{B_{nuc}}{ST^2}\right)$

(Moles)n for n = 1,2,3 (1st to 3rd moments) $\rightarrow \frac{dM_1}{dt} = \dot{N} m_0 + k_s a_A \text{sign}(\sigma) |\sigma|^b M_{\frac{2}{3}}$

4 Parameters $\frac{dM_2}{dt} = \dot{N} m_0^2 + k_s a_A \text{sign}(\sigma) |\sigma|^b M_{\frac{5}{3}}$

Intermediate moments obtained via logarithmic Lagrange interpolation $M_{\frac{2}{3}} = N^{\frac{1}{3}} M_1^{\frac{2}{3}} \quad M_{\frac{5}{3}} = M_1^{\frac{1}{3}} M_2^{\frac{2}{3}}$

Model Results

Qualitative agreement between measured obscuration and predicted mass precipitated

Some discrepancies in the “calibration factor” between obscuration and mass concentration

Larger adjustment needed for intermediate concentrations while a smaller correction needed for low concentrations



Improvement needed in distribution models

Predicted size distributions are too narrow – little variation in final predicted diameters (too much nucleation?)

Related more to model form than parameters chosen



Conclusions

- Processes for recycling algae nutrients in the form of struvite are being developed
- Algae have been successfully cultivated using struvite as nutrient source
- Struvite precipitation kinetics in a well controlled conditions have been studied
 - Size distributions, induction time, kinetics all strongly depend on supersaturation conditions
- Generally reasonable modeling results
 - Thermodynamics must be addressed for improvement
 - Mixing effects may need to be included

Future Work

Based on work by Kofina et al.², added organic materials likely to be found in the algae extract are likely to negatively impact struvite precipitation

Quantifying and developing models capable of predicting these effects is ongoing



²Kofina et al., *Crystal Growth and Design*, 7(2007)2705-2712

Figure 1. Stability diagram for struvite in synthetic wastewater: In the absence of additive (■), in the presence of 1 μM citrate (●), and in the presence of 1 μM phosphonate (○).



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