

# **Report for 2005DE59B: Nickel Sorption Kinetics at the Goethite/Water Interface: Effects of Ionic Strength and 2-[N-Morphalino]-ethanesulfonic acid (MES)**

## Publications

- Water Resources Research Institute Reports:
  - Sparks, Donald L., Brian Rosen, and Ryan Tappero, 2006, Nickel Sorption Kinetics at the Goethite/Water Interface: Effects of Ionic Strength and 2-[N-Morphalino]-ethanesulfonic acid (MES), Delaware Water Resources Center, University of Delaware, Newark, Delaware, 19 pages.
- Other Publications:
  - Boyd, Amy, ed., 2005, Delaware Water Resources Center WATER NEWS Vol. 6 Issue 1 "DWRC Announces New Undergraduate Interns for 2005 – 2006", <http://ag.udel.edu/dwrc/newsletters/Summer2005.pdf>, p. 4-5.

## Report Follows

## Undergraduate Internship Project #7 of 17 for FY05



*“Nickel Sorption Kinetics at the Goethite/Water Interface: Effects of Ionic Strength and 2-[N-Morpholino]-ethanesulfonic acid (MES)”* is the research topic investigated by **Brian Rosen** with his advisor Dr. Donald Sparks of the **University of Delaware** Department of Plant and Soil Sciences (**PLSC**). The **DWRC / PLSC** cosponsored project studied what effect, if any, the use of an acid commonly assumed valuable in environmental pollution testing may have on the accuracy of

experiments assessing water contamination.

*“My DWRC project allowed me to take an engineering approach to solve for sorption mechanisms. I have learned how to design batch experiments in order to reveal the sorption kinetics of M.E.S (acid) and Nickel to the mineral goethite and have gained experience in using the analytical equipment needed to monitor my experiments.”*  
-- **Brian Rosen**

### Abstract

Soil chemists use batch sorption experiments to measure metal and oxyanion retention by soil and soil components to predict their fate and transport in the environment. Solution pH is a master variable influencing the thermodynamics and kinetics of sorption reactions on mineral surfaces, and therefore must be carefully controlled in batch sorption experiments. Buffers offer an effective means to control pH. However, buffers may interact with dissolved species or mineral surfaces. Batch sorption experiments (pH 6.5, 1.0 g/L solid, 500  $\mu\text{M}$  sorbate, 24 - 48 hrs) were conducted to investigate the interaction between a common sulfonic acid buffer MES (2-[N-Morpholino]-ethanesulfonic acid) and goethite ( $\alpha\text{-FeOOH}$ ). Preliminary data indicated MES sorbed to goethite ( $\Gamma = 12 \mu\text{mol/m}^2$ ) in low ionic strength conditions ( $I < 0.005 \text{ M}$ ), but sorption was minimal at higher ionic strengths ( $I > 0.1 \text{ M}$ ), which indirectly suggested MES formed predominantly an outer-sphere complex. Additional evidence from FTIR flow-cell experiments reinforced the macroscopic batch data. Splitting of a single IR active band ( $\sim 1050 \text{ cm}^{-1}$ ) into two IR active bands occurred after exposing dissolved MES buffer (pH = 6.5) to a thin film of  $\alpha\text{-FeOOH}$ , which indicated an interaction between MES and the mineral surface. However, disappearance of the bands occurred rapidly when the influent flow-cell solution was changed to 0.01  $\text{M}$  NaCl, suggesting the majority of MES was weakly bound to the  $\alpha\text{-FeOOH}$  surface. The influence of MES buffer-mineral interactions on Ni sorption kinetics was investigated. Total Ni loading was similar in buffered and unbuffered systems at both low and high ionic strengths ( $\Gamma = 1.2 \mu\text{mol/m}^2$ ), which indirectly suggested Ni forms an inner-sphere complex on  $\alpha\text{-FeOOH}$ . However, the short-term Ni sorption kinetics ( $< 20 \text{ min}$ ) were slightly different for the buffered systems at high and low ionic strength and for the buffered and unbuffered system at constant ionic strength, which suggested Ni sorption was influenced by interaction of MES with  $\alpha\text{-}$

FeOOH. Results suggest “Better” buffers may not always be considered as inert components in experimental batch systems, and may unexpectedly affect sorption kinetics.