OCEANIC PHOSPHORUS RECOVERY

A study of adsorption process design and scale-up

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Phosphorus as a Depleting Resource

- An essential element in sustaining agriculture (fertilizer)
- Agriculture runoff deposits phosphate into rivers & oceans
- US Phosphorous reserves are projected to last ~ 50 years

Dangers of Excessive Phosphorus Use

- Depletion of phosphorous → expensive fertilizer → global food crisis
- Eutrophication → Dead zones
- Algal blooms → poisonous seafood

Mission Statement

Design a process that aids in the

efficient recovery of phosphorus from seawater

for uses of environmental and agricultural sustainability

Our Process

- Production of nanocomposite
  - Separate process - batch synthesis
  - Production of nanocomposite is as needed
  - Can be regenerated and reused
- Processing of seawater:
  - pH Control
  - Collection of phosphate with highly selective adsorbent
  - Wastewater Treatment
- Recovery of Phosphate:
  - Precipitation reaction conditioning (initial concentration, pH)
  - Solid / Liquid Separation (Centrifuge, Decanter)
  - Drying of solid product

Nanocomposite Adsorbent

- MgAlZrOH
  - Composite of Mg-Al double salt and amorphc form of ZrOH solid
  - Can be reused and regenerated
- High Phosphate Selectivity
  - Constant uptake of 35 mg-P/g of solution
  - Necessary due to anion richness of seawater
  - Uptake is superior to individual components
  - Uptake optimized at solution pH of 6
- Average particle size → 2.7 nm

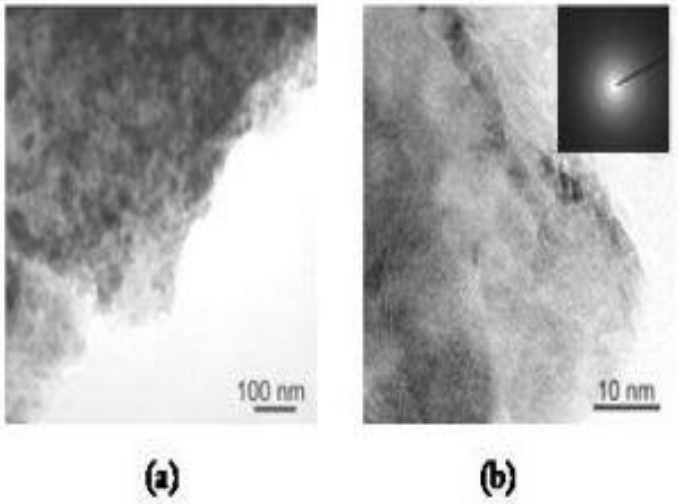
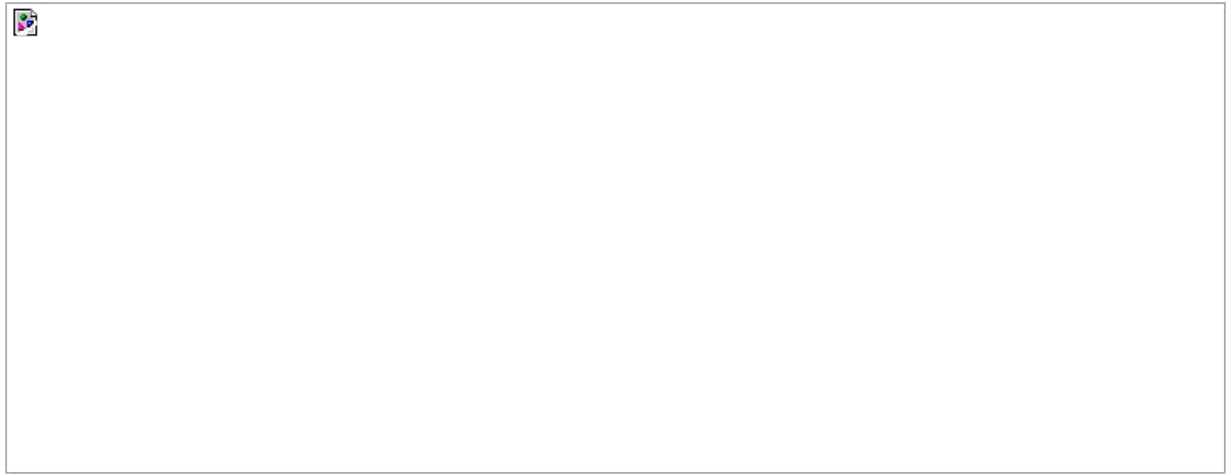


Figure 18. TEM images of the c-MgAlZrOH sample

Collection of Phosphate

- Acidification of seawater for optimized adsorption
- Solution fed to packed column (MgAlZrOH adsorbent)
- Remaining seawater neutralized with NaOH & released



Recovery & Conversion of Phosphate

A Path Forward

- Continue with synthesizing a significant amount of nanocomposite
- Batch testing of a concentrated phosphorus solution to measure column efficiency, and optimize adsorption.
- Incorporate automatic process control with electric pumps - move away from vacuum filtration.
- Test regeneration of the nanocomposite and obtain more funding for raw material.

Conclusions

- We project for an 8000 L seawater batch system to recover 1.89 grams of Phosphorus
- inexhaustible supply of seawater phosphorus
- Economic viability predicted for large plant capacity
- Synthesis of nanocomposite is laborious and the project will benefit from at least a three-fold scale up.

Acknowledgements and Q&A

SPECIAL THANKS:

Professor Jan Talbot & Darren Lipomi for providing laboratory access

Professor Justin Opatkiewicz for advising & supplies assistance

TGIF / AIChE / & TESC for our funding

AIChE Projects Leadership for creating the program

Thank You