AQUEOUS REMEDIATION OF PERSISTENT ORGANIC POLLUTANTS USING MAGNETIC NANO-IRON SORBENT

Lydia Sannella; Chemistry Major; College of Marin
Mentors: Kristin Clark & Reginald Thio; Faculty supervisor: Arturo Keller
Bren School of Environmental Science and Management, UCSB

1. Introduction

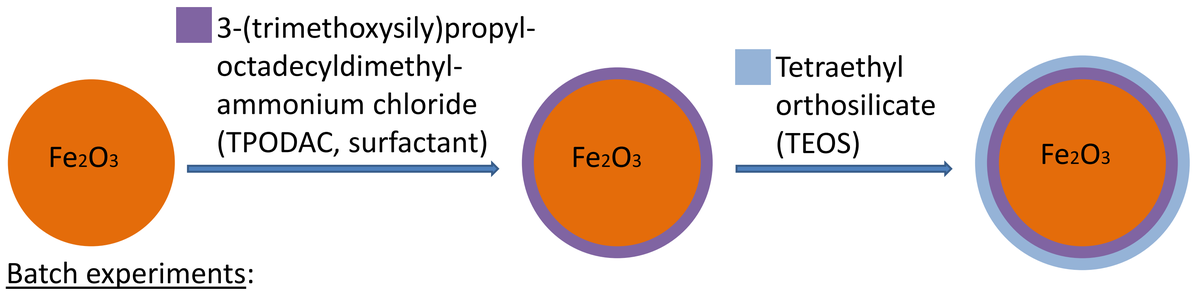
- Hydrophobic Organic Compounds (HOCs) are ubiquitous, non-biodegradable pollutants.
- Activated carbon is the standard sorbent for removing these pollutants.
  - Requires pumping and treating water to use.
- Magnetic Permanently Confined Micelle Arrays (MagPCMA) are magnetic sorbents that can be used to treat polluted water in-situ in a single step.
- MagPCMA structure:
  - Maghemite core: magnetic, allows for removal from aqueous media
  - Surfactant: Binding site for HOCs
  - Porous silica coating

Figure 1.1: MagPCMA as seen without magnification

Figure 1.2: Comparison of various grades of activated carbon

2. Methods

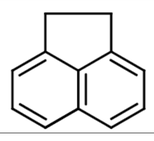
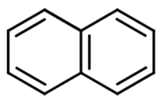
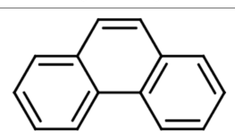
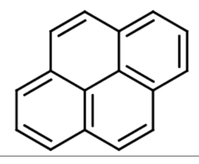
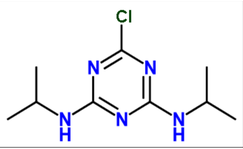
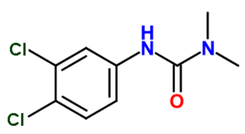
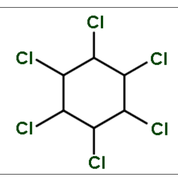
Figure 2.1: Synthesis of MagPCMA:



Batch experiments:

- Two classes of HOCs tested: Polycyclic Aromatic Hydrocarbons (PAHs) and chlorinated hydrocarbons.
- Samples of MagPCMA and activated carbon dosed with HOCs and allowed to equilibrate 24 hours.

Figure 2.2: Table of Hydrophobic Organic Compounds and Their Physical Properties

Compound Type	Compound	Structure	Molar Mass (g/mol)	Solubility in H_2O (mg/L)	K_{ow}
Polycyclic Aromatic Hydrocarbons	Acenaphthene		154.211	4	8317.6
	Naphthalene		128.171	31.9	3235.9
	Phenanthrene		178.233	1.28	28840.3
	Pyrene		202.255	0.135	61659.5
Chlorinated Hydrocarbons	Atrazine		215.686	33.0	478.6
	Diuron		233.097	42	263.0
	Lindane		290.832	7.30	5754.4

Analysis:

- Absorbance spectrophotometry, GC-MS, and HPLC used to determine concentrations of HOCs after equilibration

3. Results

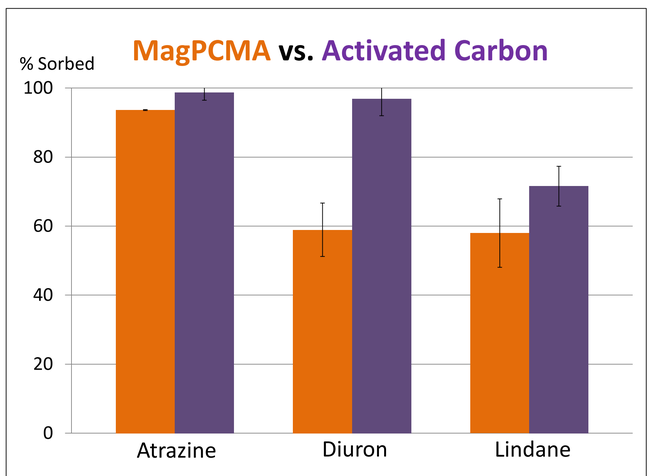
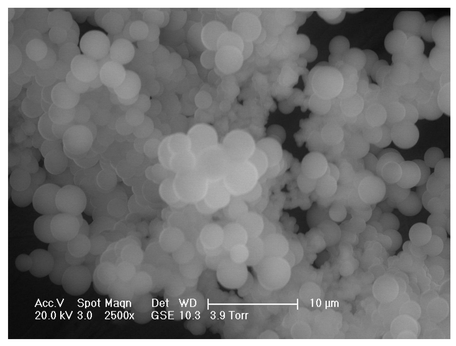


Figure 3.1: Sorption of chlorinated hydrocarbons by MagPCMA and activated carbon. Comparison with figure 3.3 shows that MagPCMA is more effective at sorbing Atrazine and Acenaphthene than more highly chlorinated hydrocarbons and larger PAHs.

Figure 3.2: SEM image of MagPCMA. The iron core is nano-sized. The addition of TPODAC and TEOS make the silica-coated micelle micron-sized.



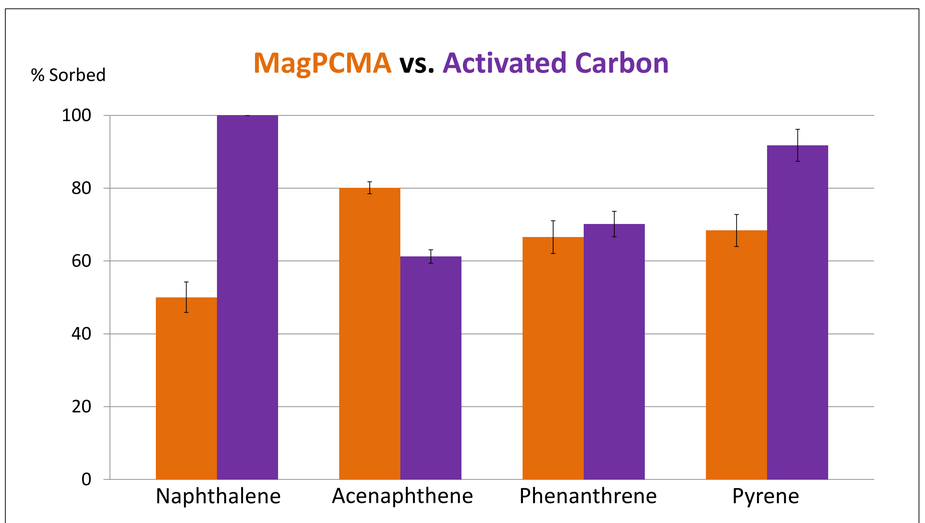
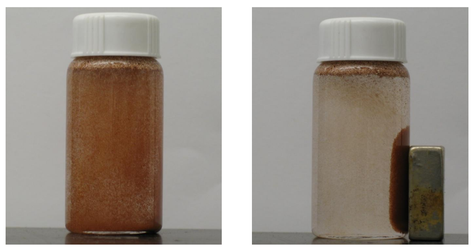


Figure 3.3: Sorption of PAHs by MagPCMA and activated carbon. MagPCMA is competitive with activated carbon at sorbing acenaphthene and phenanthrene, suggesting that it could be used to target those specific compounds.

Figure 3.4: MagPCMA in suspension; MagPCMA attracting to a magnet. The magnetic nature of MagPCMA allows it to be recovered easily with a magnet. MagPCMA could be used in the field for in-situ treatment of contaminated water without having to pump and treat the water externally.



4. Conclusions

- MagPCMA capable of sorbing both PAHs and chlorinated hydrocarbons
- MagPCMA can be used to target specific compounds and then removed magnetically with minimal ecological impact.
- Further research: reusability of the material, extractability of sorbed HOCs, studies to determine whether surfactant or silica left in solution, studies using coarser commercial-grade carbon

Acknowledgements

The Keller Lab: PI Dr. Arturo Keller, mentors Kristin Clark and Dr. Reginald Thio, undergraduate researchers Annabelle Lee, Colin Van Zandt, and Marc Stefanuto.

INSET: Jens-Uwe Kuhn, Nick Arnold, Arica Lubin, Liu-Yen Kramer

Funding: National Science Foundation, Environmental Protection Agency, Toxic Substances Research & Training Program

Figure 1.2: Activated carbon image taken from International Commerce Corporation