US EPA ARCHIVE DOCUMENT

Sustainable Sorbents and Monitoring Technologies for Small Systems

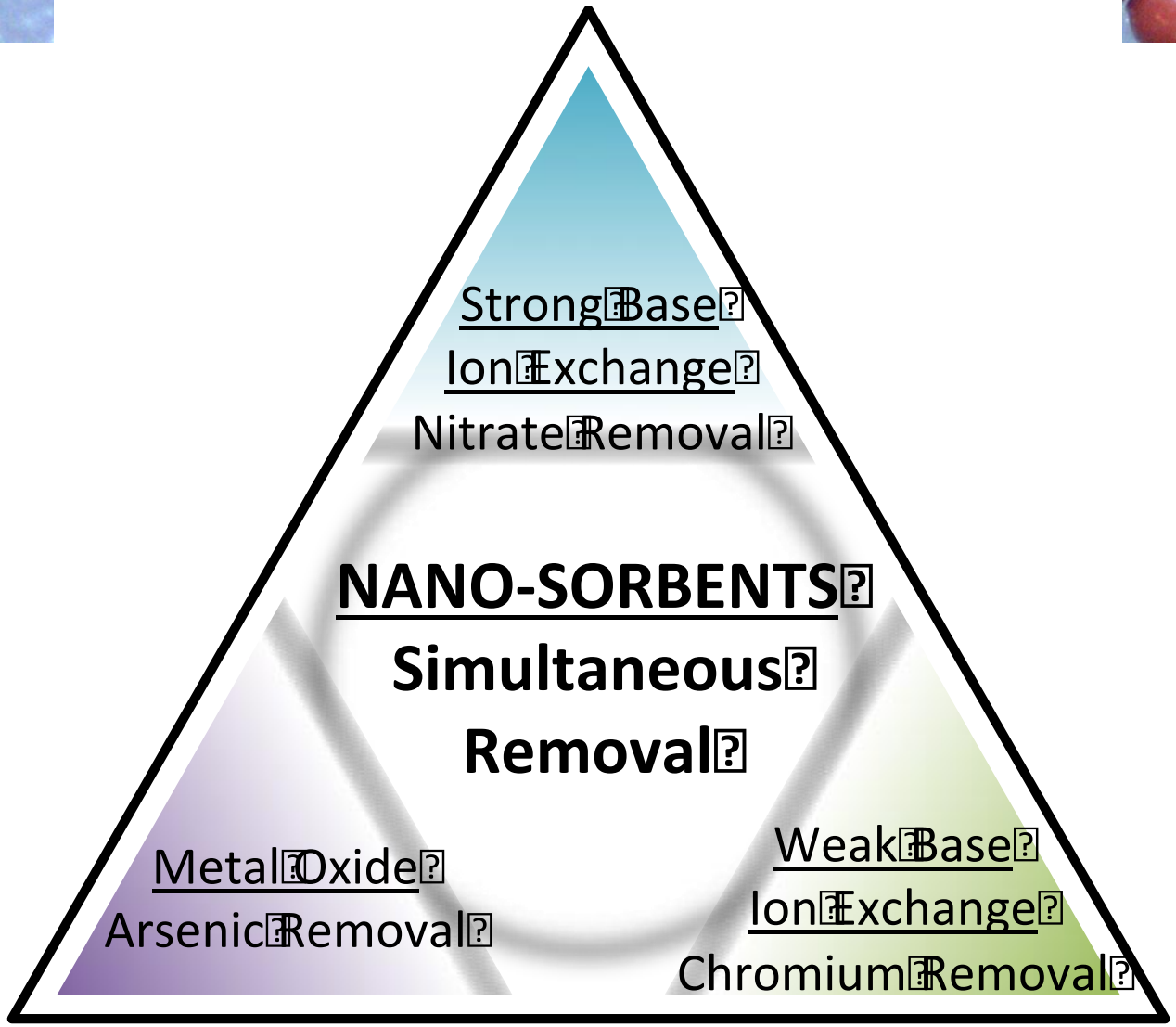
Paul Westerhoff, Kiril Hristovski,
James Gifford, Heather Stancl, Allie Bowen,
Aaron Dotson

Project Goal: Develop innovative treatment and monitoring technologies for small drinking water systems to remove common groundwater contaminants in extreme environments.

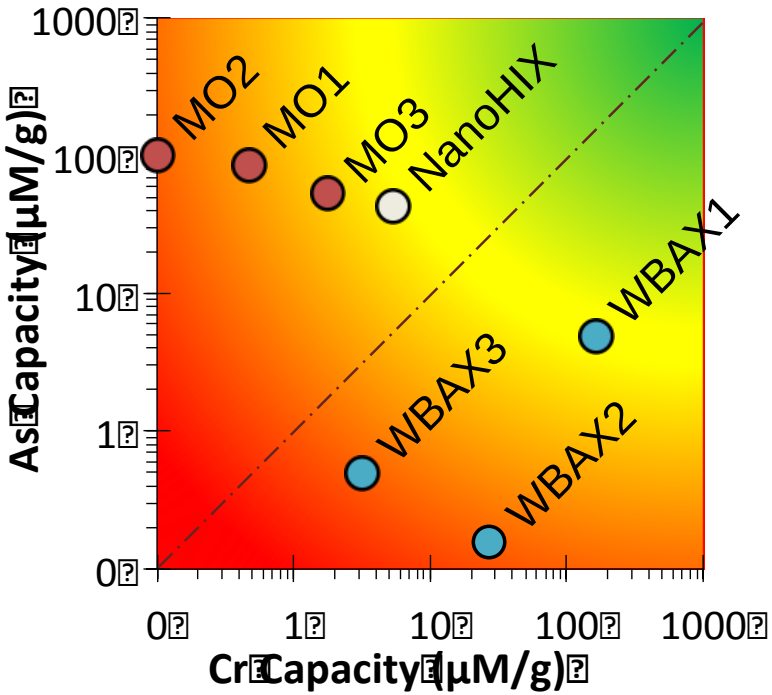
The Challenge

- Small groundwater systems are increasingly having to deal with removing multiple inorganic and/or organic contaminants (As, Cr(VI), NO_3^-, DBP precursors).
- We are exploring nano-enabled sorption processes to achieve simultaneous removal of pollutants.
- Many small groundwater systems are in remote areas and want local, sustainable solutions. We are exploring use of biochar based treatment technologies.
- Monitoring long-term pollutant exposure and near real-time operational data is a challenge for small systems, and we are exploring potential solution strategies.
- Working with small systems, and native American communities bring about new and unexpected social experiences.

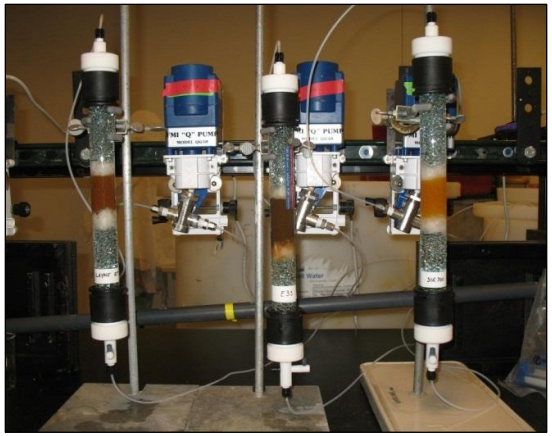
Concept for Inorganics



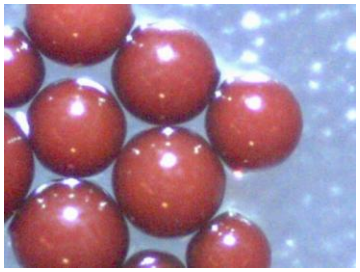
Approach: Batch experiments transitioning to column tests



A commercially available nano-enabled sorbent (NanoHIX) showed a higher capacity to sorb 2µM Cr and As simultaneously in pH 8 CW in equilibrium testing than other commercially available metal oxide (MO) or weak base anion exchange (WBAX) resins.

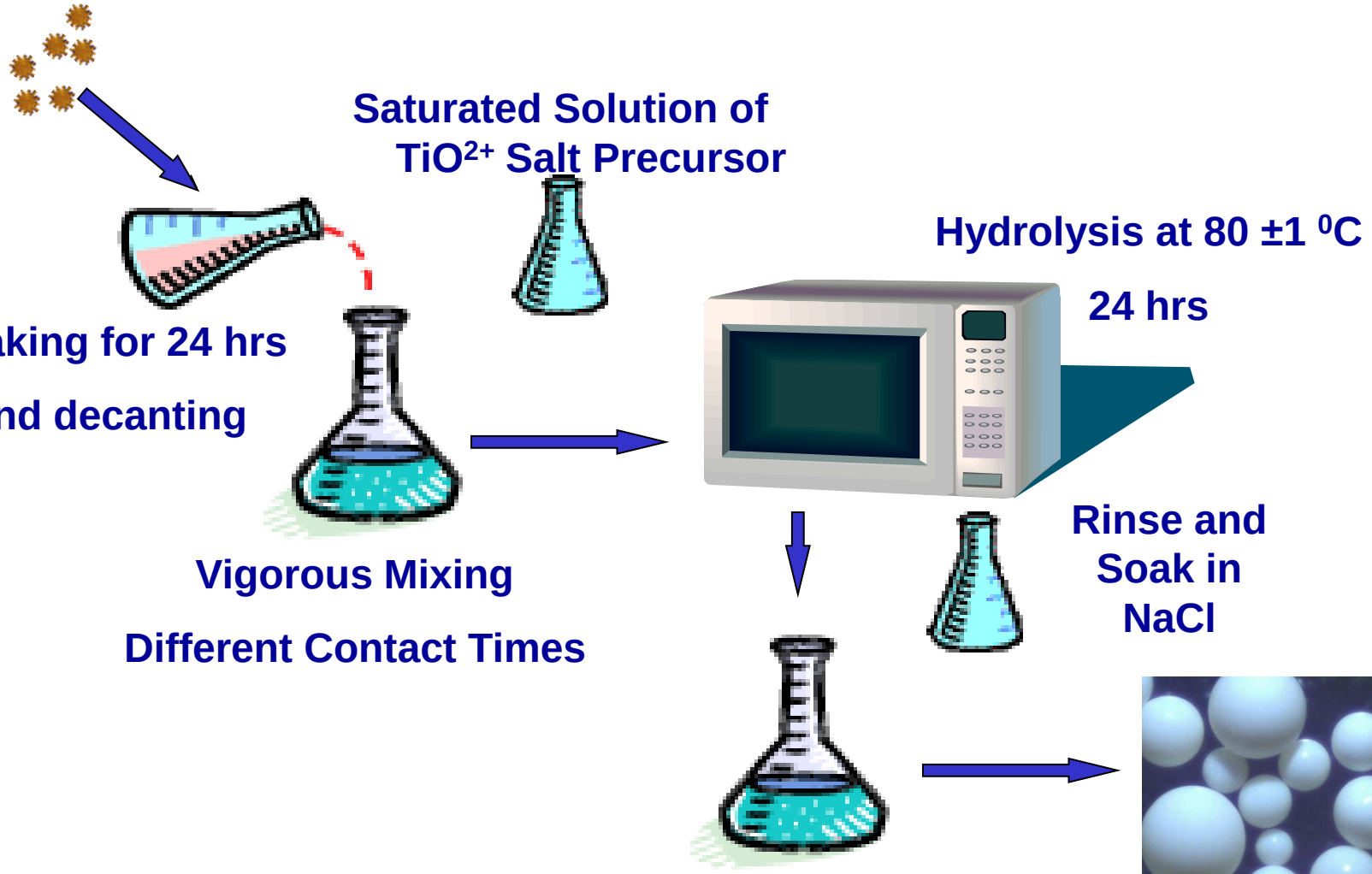


Methodology



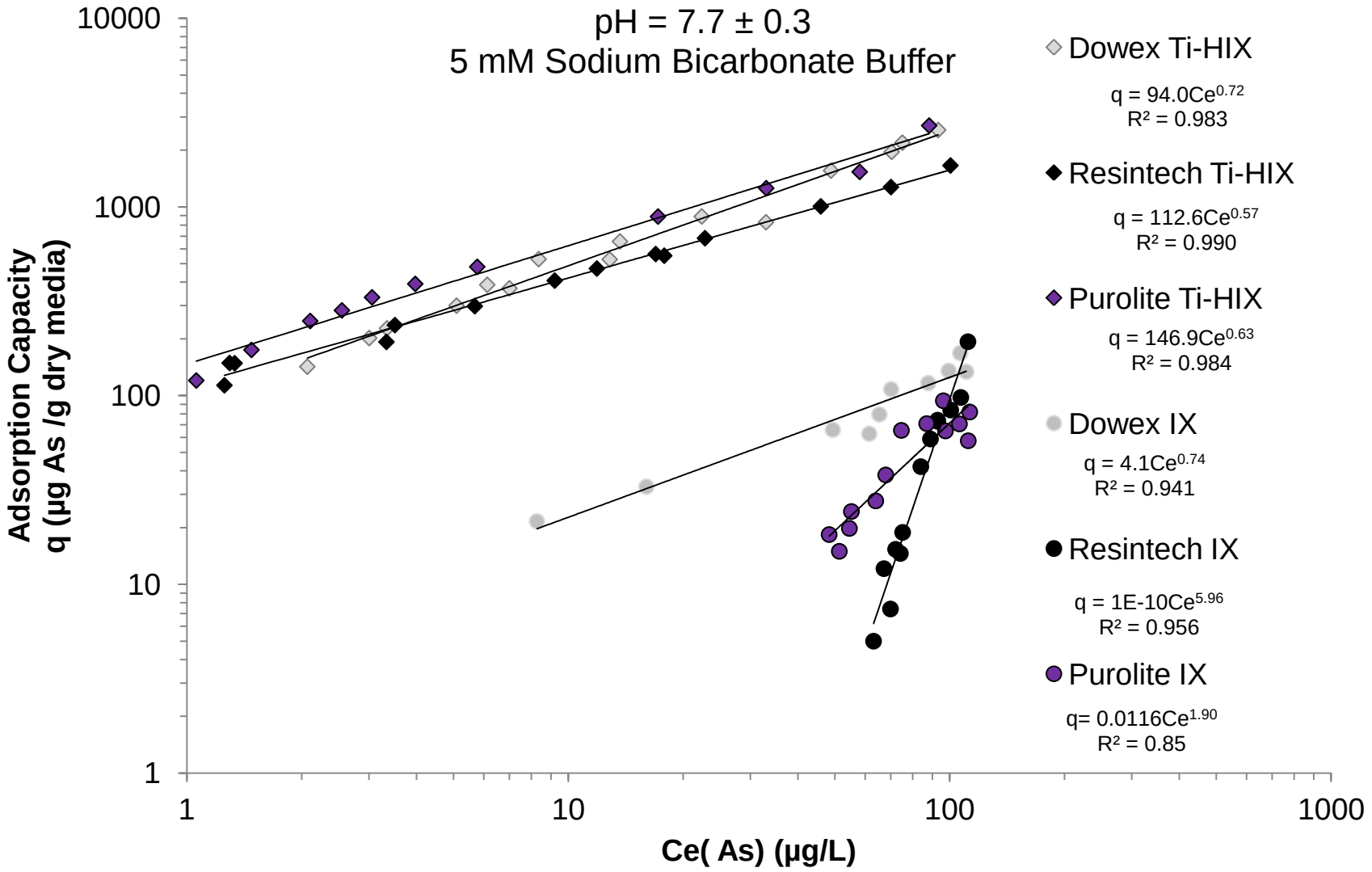
Overview of Media Synthesis

Ion-Exchange Media



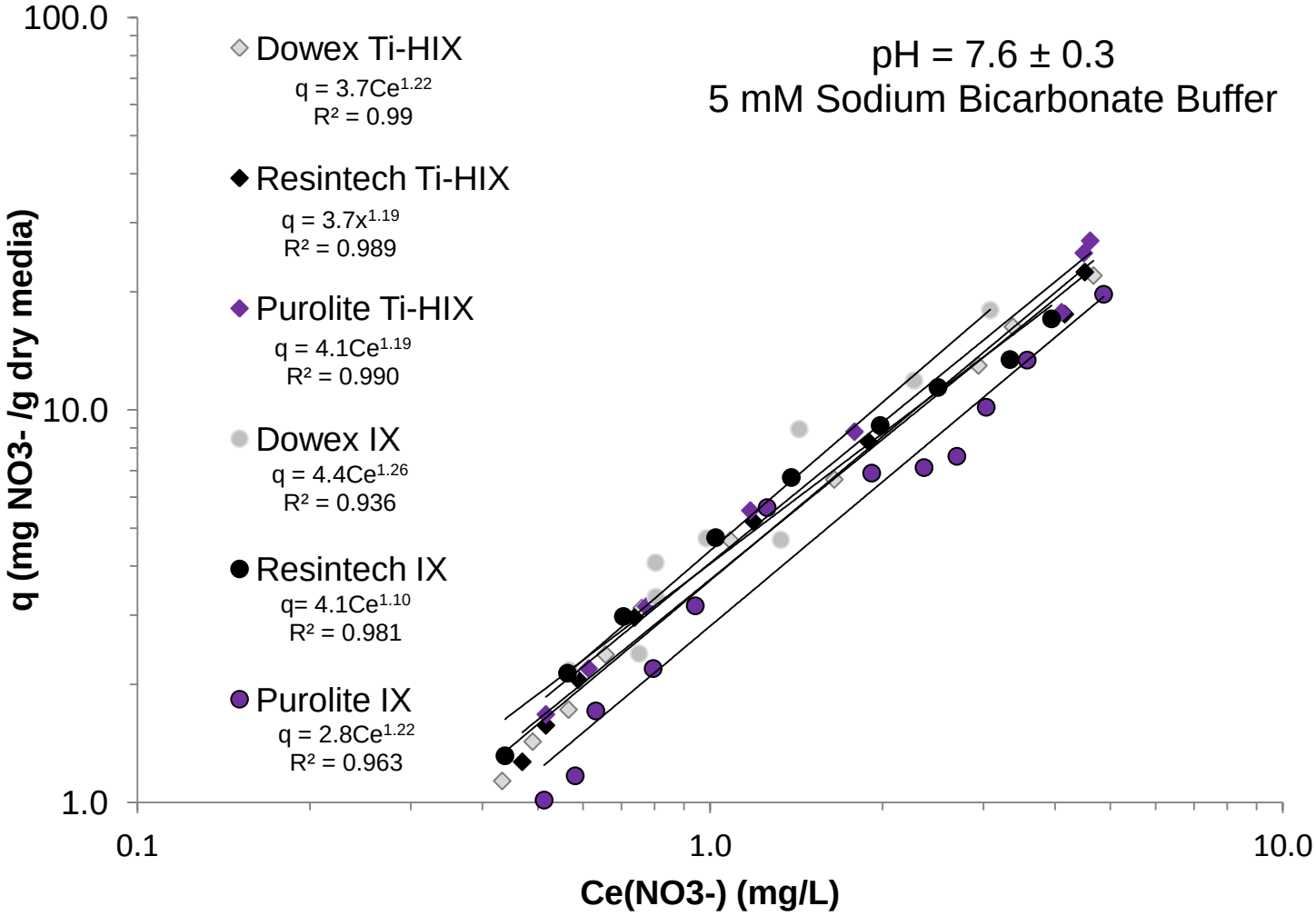
Results – Strong Base IX with TiO_2

Arsenic Removal



Results – Strong Base IX with TiO_2

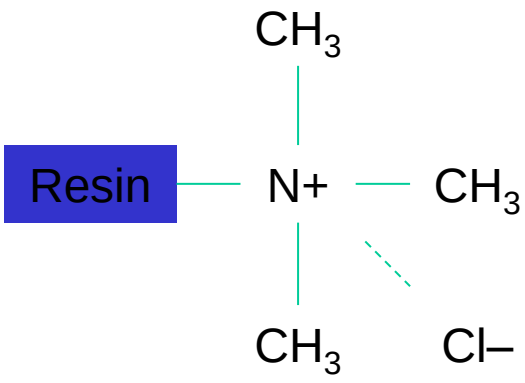
Nitrate Removal



Anion Exchange

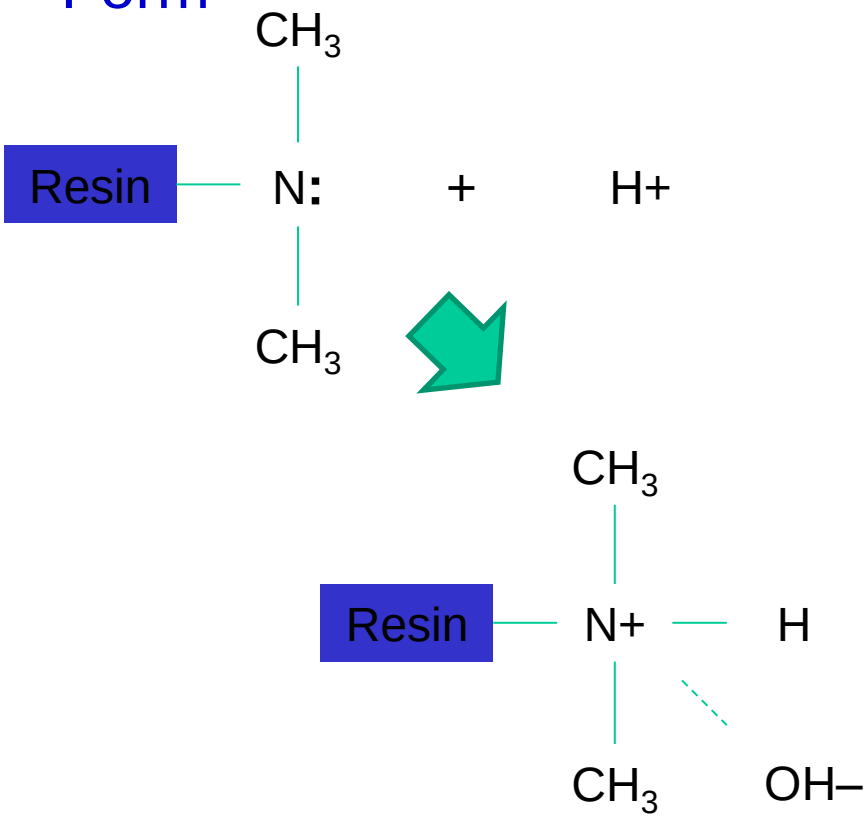
Strong Base

- Quaternary Amine
- Chloride Form
- Has been used in prior HIX applications



Weak Base

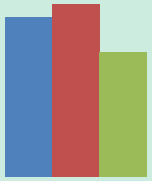
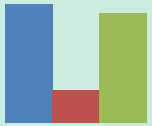
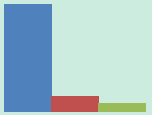
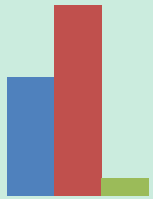
- Tertiary Amine
- Free Base (Hydroxide) Form



Resins Tested

	SIR100	S106	PWA7	SIR700	LayneRT
Raw					
Raw+ nFe					
Raw+ nFe + Acid					

Pollutant Removal in NSF53 Challenge Water

Cr As N (%)	SIR100	S106	PWA7	SIR700	LayneRT
Raw+ nFe + Acid	73 79 57 	52 43 6 	49 46 7 	47 35 10 	-
Raw+ nFe	49 49 48 	23 26 2 	15 32 1 	16 22 3 	-
Raw	54 15 50 	31 14 3 	49 7 4 	46 16 5 	54 87 8 

100ppb Cr, 144ppb As, 2000ppb NO3-N

Separation Factors

	$\alpha_{Cr/As}$	$\alpha_{As/NO3}$	$\alpha_{NO3/Cr}$
PWA7	13.4	1.6	0.1
PWA7+nFe	0.4	34.3	0.1
PWA7+nFe +acid	1.1	12.2	0.1

Can BioChar replace Alum Coagulants or GAC in rural Alaska?

- BioChar is a recalcitrant carbonized form of organic matter (including trees, grasses, Ag wastes)
- Carbonized under thermal conditions less intense than activated carbon
- Does it work in drinking waters to remove DBP precursors, and/or inorganics if hybridized?

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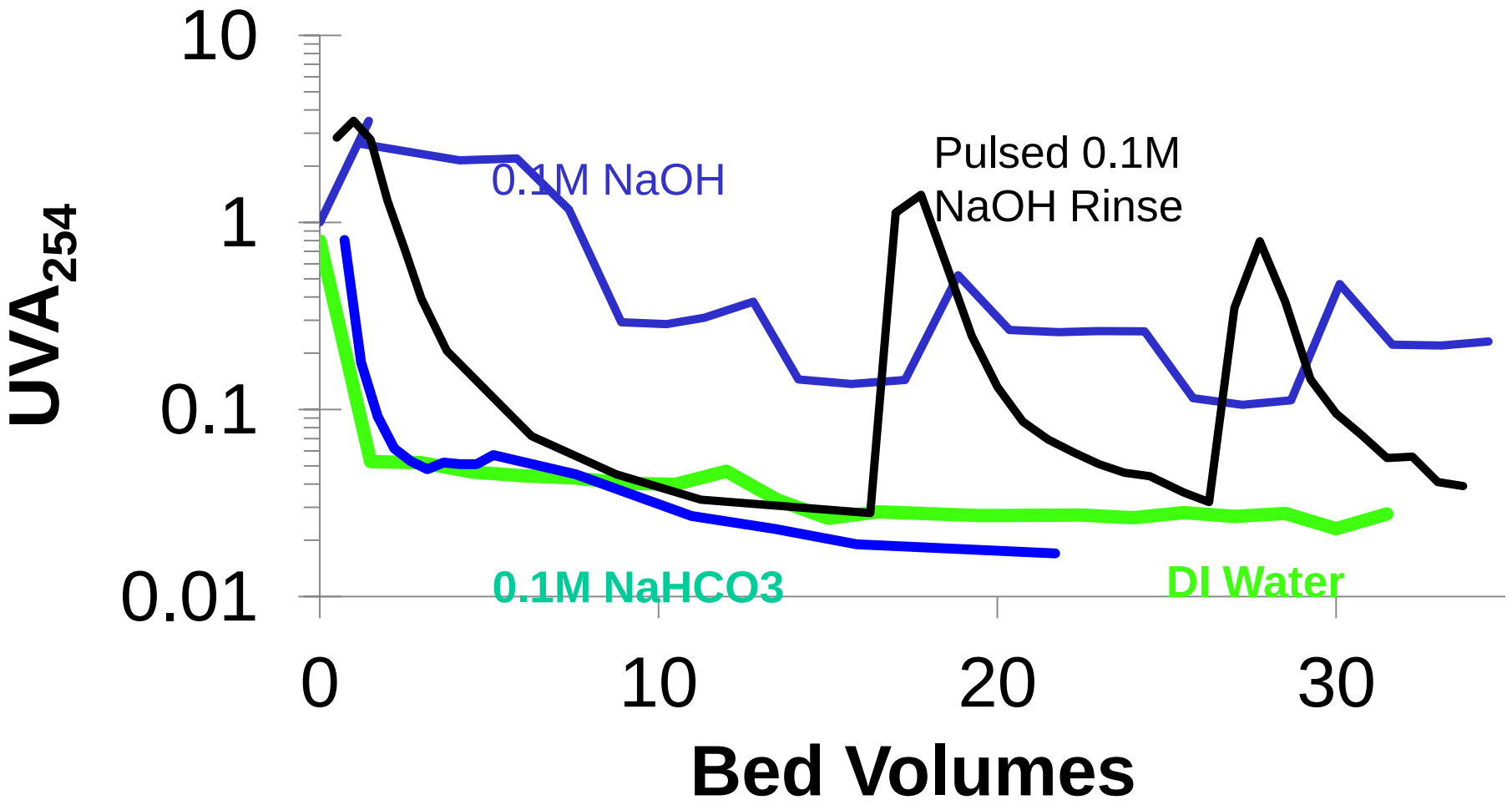
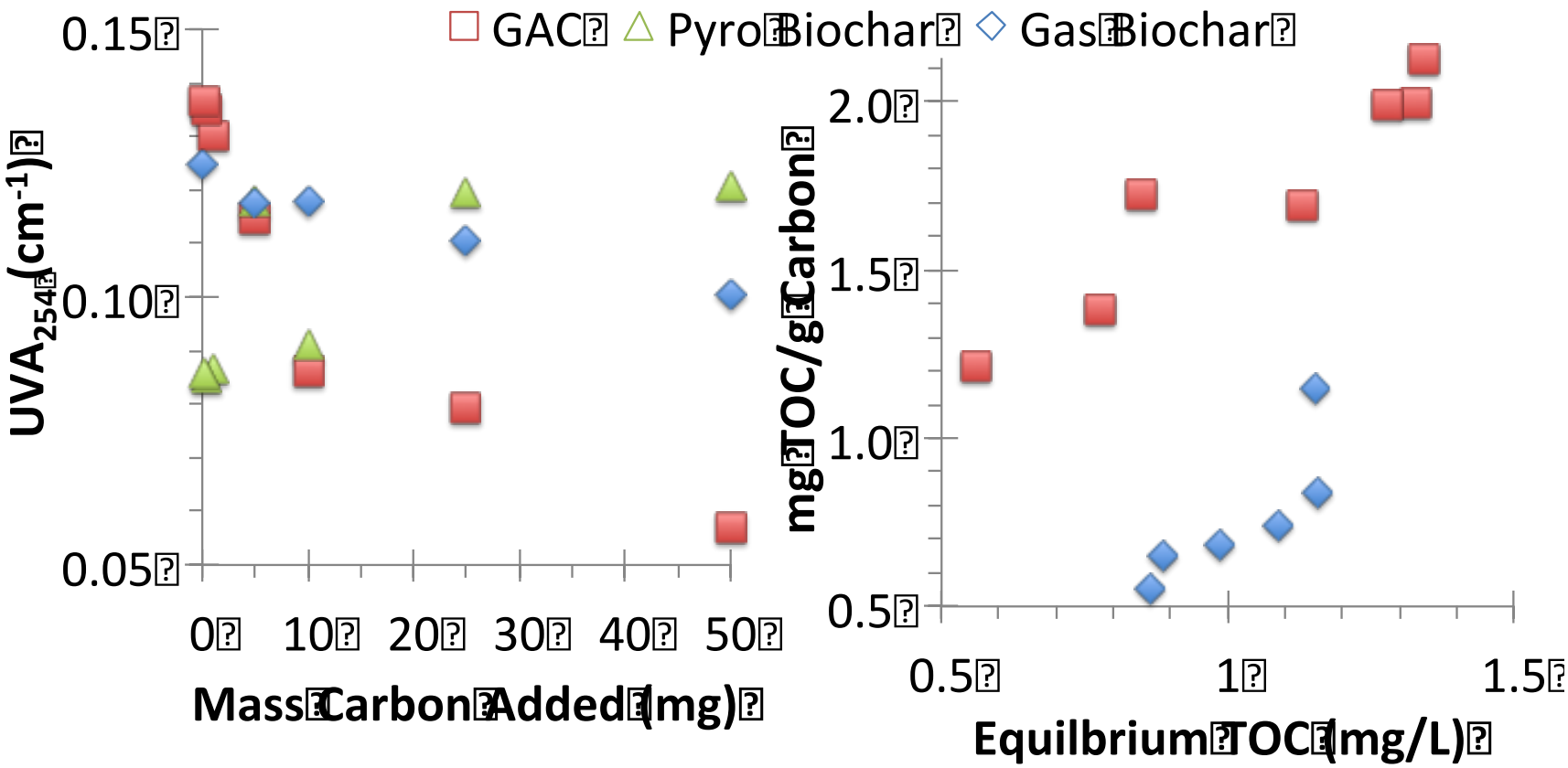
Biochar packed columns leach some UV254 organics

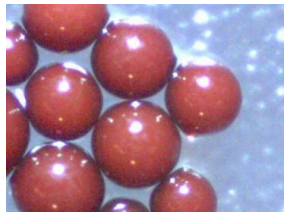


BioChar synthesis effects UV254 & TOC leaching and net TOC removal



Highlights & Path Forward

- First synthesis of HIX using *weak base* IX material
- Impregnating IX resins with Iron & Titanium oxides
- Impregnating spherical IX resins & new nano-structured resins
- HIX that can simultaneously remove 3 important oxo-anions (NO_3^-, As, Cr(VI))
- Biochar carbonization influences DOC sorption. Will evaluate creation from different states of life (living, fire kill, beetle kill). Will impregnate with Fe & Ti oxides.
- Developed a framework for on-line monitoring using inexpensive UV-VIS spectral monitoring (S::can)



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