Arsenic Removal Research Sponsored by Awwa Research Foundation

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2005 AwwaRF Arsenic Project Reports

- Arsenite oxidation by solid-phase media or a UV-sulfite process
- Adsorbent treatment technologies for arsenic removal
- Rapid small scale column testing for evaluating arsenic adsorbents
- Innovative alternatives to minimize arsenic, perchlorate, and nitrate residuals
- POU/POE implementation feasibility study for arsenic treatment

As(III) Oxidation

- Methods
  - Solid Oxidizing Media (SOM): Filox-R, Pyrolox, BIRM, manganese greensand
  - UV-sulfite process

As(III) Oxidation: SOM

- Without interfering reductants (IfR)
  - As(III) = 50 µg/L
    - All but BIRM preformed well
  - As(III) = 1,000 µg/L & low DO
    - Filox-R & Pyrolox still performed

As(III) Oxidation: SOM

- Presence of IfR
  - S^{2-} & low DO
    - Pyrolox > Filox-R
  - Fe(II) & low DO
    - Filox-R > Pyrolox
    - Fe(II) > 1 mg/L: both ineffective
  - IfR effect: Fe(II) > S^{2-}

UV-Sulfite Process

- Bench scale: effective
  Field: ineffective
- Key factors
  - pH: high (> 8.5)
  - DO: high
  - S^{2-} interferes

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Adsorbents

- Media types:
  - Fe-modified AA: AA-FS50
  - Fe-based: E33, GFH
  - Ti-based: MetSorb G,
  - Fe-modified zeolite: Z33-B

Adsorbents

- Capacity by weight: E33 ~ GFH ~ MetSorb G > AA-FS50 > Z33-B
- Least affected by competing anions: MetSorb G
- As(III) removal: E33 > MetSorb G > GFH
- As(V) removal in NSF challenge water at pH 7.5: MetSorb G > E33 > GFH

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RSSCT

- Media: AA-FS50, E33, GFH, SANS
- Media pH_{PZC}: 6.4 – 7.7
- Breakthrough bed volumes
  - SANS > E33 > GFH >> AA-FS50
  - Strongly dependent on pH

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As Residuals

- Backwash water
  - Minimization by prefiltration
  - Treated BW water recycle
- Sludge stabilization
- Brine solidification

Backwash Water

- Minimization (prefiltration):

  5µm cartridge > Sand >

  10µm cartridge > 5µm bag
- Recycle (spent BW treatment):
  - Low particulate As in spent BW
  - Coagulation-sedimentation > filters

Sludge Stabilization

- $FeCl_3$ sludge tested
- Stabilization
  - 10% & 20% fixative: cement > lime
  - 50% fixative : lime > cement
- Recommendation: LIME (cost competitive)

Brine Solidification

- Innovative method:
  Ca-Fe doped hydrogel
- Phosphate & sulfate interfere
- TCLP: passed
- WET: additional stabilization needed

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POU & POE

- Types
  - AA, Fe-AA, Mn-AA, Granular Fe
  - 2 RO membranes
- In-home (POU) & field (POE) testing

POU & POE

- POU

  RO & Mn-AA: As < detection limit after 12 mo.

- POE:

  All units treated > 50,000 Gal before 10µg/L As breakthrough, except Fe-AA

POU

Monitoring Options

- 1 sample / household / year (#1)
- 1 sample /4 households / year + yearly replacement (#2)

	#1	#2
Adsorb.	$26/mo	$25/mo
RO	$31/mo	$28/mo

POU & POE

Cost Comparison

- POU < centralized when
  - Adsorption: < 200 connections
  - RO: <120 connections
- POE > centralized (by 39 – 48%) for 20 – 300 connections

Ongoing Projects

- Treatment technologies
  - Ti & Zr coagulants
  - Polymeric ligand exchanger
  - Adsorbents
    - Nanoparticle media
    - Fe/Mn aerogel-GAC
    - Fe-GAC
    - Ti & Zr nanocomposites
    - Hydrogel
    - Fe-coated fibers
    - Ferrous carbon beds
    - Treated coat ash
    - Regenerable vs. non-regenerable
  - Electrocoagulation–filtration

Ongoing Projects

- Secondary impacts
- Unintentional pH variation
- Filter backwash water minimization
- Residual stabilization
- Subsurface treatment
- Surface complexation + dynamic transport modeling

Questions?

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