

Session 20, 4/26/07

**Guest Lecturer: Abul Hussam: “Arsenic in Drinking Water” First Prize Winner of the Grainger Competition**

- Today’s class attended a lecture by Abul Hussam hosted by the Civil and Environmental Engineering Department
- Prof. Hussam trained as an aquatic chemist and applied it to arsenic mitigation
  
- Tube-wells in Bangladesh
  - Up to 4000ppb As (total)
    - Bangladesh limit: 50µg/L
    - In groundwater, concerned about As(III) and As(V)
  - One is more toxic, but convert in the body
    - 500 million people may have been exposed to excess As in Bangladesh and nearby countries
    - Shallow and deep tube wells both contaminated
    - (deep wells may not be a solution)
    - Arsenic concentration increases with age of well
  
- Aquatic Chemistry
  - Measure As (III) by anodic stripping voltammetry – electrochemical technique
  - Iron-reducing bacteria also reduce arsenic
  - No relation between Fe (II) and As (III) (in terms of correlation)
  
- Two ways, among others, to remove arsenic:
  - Allow naturally occurring Fe(OH)<sub>3</sub> complexes to settle out by gravity (natural attenuation)
  - Filtration
  
- Arsenic Mitigation through Natural Attenuation
  - “Drink water after leaving it for awhile” – in terms of science, is this a valid approach?
  - Process: leave groundwater containing iron, measure turbidity, measure composition of water and precipitate
  - Induction period before precipitation happens
  - Half-life ~ 21 hours (for precipitation with iron)
  - Use chemical equilibrium modeling to determine speciation
  - If you have 100ppb As, then natural attenuation will work to some extent – so the saying above is partially correct.

- Arsenic Mitigation through Filtration
  - 1999 – simple filter based on zero-valent iron ( $\text{Fe}^0$ ) – called “Three Kolshi” or “Three Pitcher” filter.
    - Next, switch from pitchers, which were of ceramic pots, to plastic buckets – more sturdy
    - Also started to find problems with zero valent  $\text{Fe}^0$  → moved to “Composite Iron Matrix” (CIM)
  - Current system performance: 20-60 L/hour, cost \$35-40  
Total As < 10ppb, As (III) < 2ppb  
Lifespan of at least 5 years, low maintenance
  - Also reduce iron from 5ppm → 0.2ppm
    - Even when input water has > 2000ppb As, filtrate has <10ppb
  - Compiled 3 years of data, over 100,000L filtered
    - Also looking at Manganese (known neurotoxin) – reduces Mn concentration as well
    - Starting to test effects of increasing flow rate
    - Filter life span, based on adsorption isotherm: 11.4 years done with groundwater spiked with As
    - Zero-order process – resulting As level is independent of input As concentration (so input > 4000ppb still gets you <10ppb after filtration)
    - Takes some effort to convince the community – sing songs about the filter and the dangers of arsenic, etc.
  - The CIM (composite iron matrix) can be recycled, reused... does not leach arsenic
  - Installed in schools, students take filtered water home also.