

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)₃ 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 (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 $\text{Fe}^0 \rightarrow$ 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 \rightarrow 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.

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