Chemistry of Drinking Water Treatment: A Balancing Act

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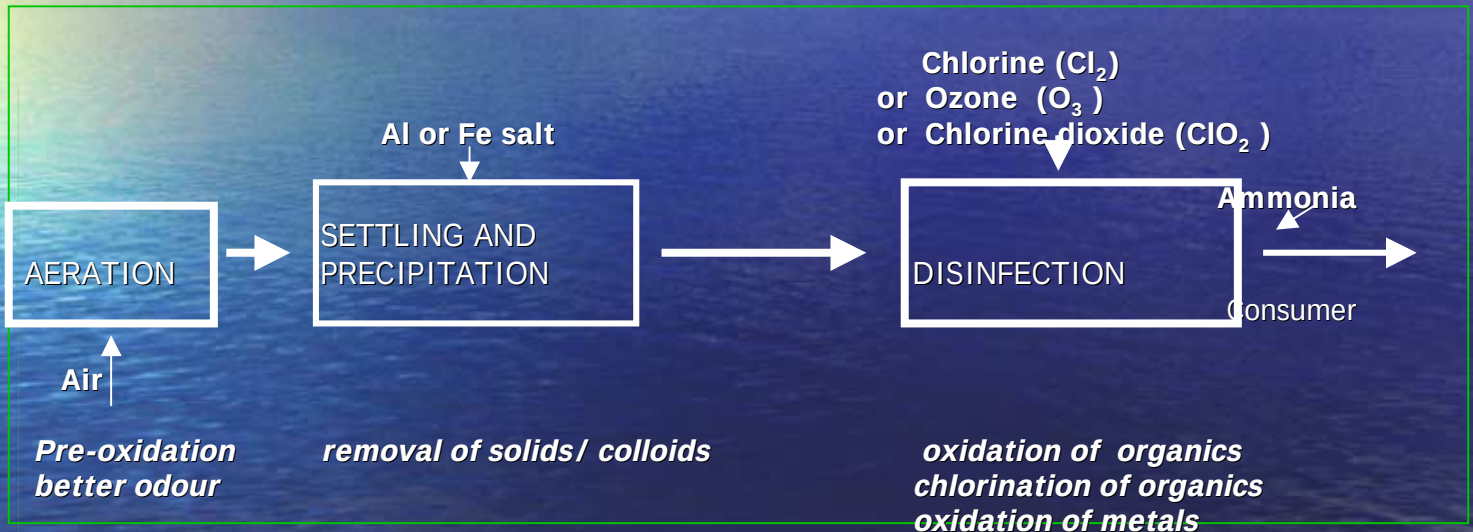
Local (Chemical) Issues

- Source of "Raw" Water
- Disinfection By-products (THMs)
- Toxic metals (As, Pb, etc.)
- Aesthetic Qualities (smell, colour)

Some Examples of “Balancing Acts”

1. Surface water *or* ground water
2. Chlorine dose *vs* THM formation
3. Cost *vs* Acceptable quality

The Conventional stages of Purification of Drinking Water



Alternative/ Additional Purification Steps

For Particular “Water Problems”

- Filtration (for high organics)
- Reverse Osmosis (for metals and organics)
- Ion Exchange (for metals)
- Activated carbon (organics, some metals)
- Filter membranes; 1 nm pores (removes viruses)

Water Disinfection
by Chlorination

- Cl_2 (g) + H_20 $\rightleftharpoons$ HOCl + Cl^- + H^+

  hypochlorous acid

- relatively inexpensive; small excess can provide residual disinfection in distribution

- Disadvantage: production of chlorinated organics such as potentially harmful Trihalomethanes (THMs)

  High amounts of THM produced from high levels of organics ; Disinfection Power affected by a number of variables

Water Disinfection

by Ozonation

- Very strong disinfectant
- Does not produce chlorinated by-products

- Disadvantages: must be generated at site. If Br^- present ,produces toxic BrO_3^- . Is unstable and has no residue protection (Cl_2 must be added for distribution)

  Requires high level of skill; ozone a more toxic gas

Water Disinfection
by *Chlorine Dioxide*

- Good substitute for chlorine; more effective
- little or no chlorinated organics formed

- Disadvantage : must be generated at site through oxidation of chlorite ion; regular tests for [chlorite]

Water Disinfection

by Ultraviolet light

- powerful mercury lamp immersed in water flow UV-C (254 nm) ; microbes dead in 10 seconds
- small units can be employed to serve small population base

- Problems arise when high iron or humic acids present in water supply. They reduce light intensity

  requires secondary disinfection for water distribution

(Analytical) Approaches to Water Supply problems

- fully characterize the chemistry of the “raw” water
- Select the best purification method based on chemistry
- Optimize water treatment based on trials runs
- Utilize research and monitoring facilities at Memorial University

In practical terms what can be done now?

First focus on what's in place now

- Site-specific chlorine demand and management survey
- Development of seasonal guidelines for chlorine doses
- Calculate THM formation potential
- Study the health of the watershed

Memorial University

Center for Chemical Analysis: Research and Training (C-CART)

- Measurement of THM, THAA and other DBPs
- Chlorine demand, chlorine decay
- Metal concentrations and their speciation
- TOC, colour and other water parameters
- Basic water treatment laboratory apparatus
- Other measurements possible
- FOCUS $\rightarrow$ *Training and Research*

SUGGESTIONS ?

COMMENTS ?

OTHER EXPERTISE AT MUN ?

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