Managing Disinfection Groundwater Rule and DBPs

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Why do we disinfect?

- Disinfectants are:
  - Toxic
  - Strong Oxidizing agents
  - Corrosive
  - Taste and Odor causing
  - Forms carcinogenic by=products
- Used to:
  - Kill bacteria and viruses
  - Inactivate protozoa and other micro-organisms
  - Break down organic contaminants
  - Keep system clean . . .er
  - Protect against cross-connections and other contamination

Do You Have to Disinfect

- Surface Water? - - - Always
- Groundwater Under the Influence (GWUDI) – Always
  - Source Testing
- Groundwater Sources
  - Protected Groundwater – Maybe not, State dependent
  - Groundwater Studies
  - Source Testing

Disinfectants

- Chlorine
  - Gaseous Chlorine
  - Hypo-chlorination (Na, Ca)
  - Chloramines (Chlorine and Ammonia)
- Ultra-Violet
- Ozone
- Chlorine Di-Oxide

Gaseous Chlorine

- Mainly large systems
- Cheapest to operate
- 100% available chlorine
- VERY hazardous
- Extensive safety features
- Used less and less

Chloramines

- Add chlorine for contact requirements
- Add ammonia to give extended residual
- Less corrosive, less reactive, less DBPs
- Mainly large systems with big distribution systems

Hypo-chlorination

- Most small systems
- Slightly more expensive than gas
- Little or no health hazard
- No special design (containment)
- Sodium – NaCl2 – liquid bleach
  - 5 – 15% chlorine
  - Feed pump directly to water line
- Calcium – CaCl2 – powdered
  - 65% chlorine
  - Explosive
  - Mixed with water before feeding

Ultra-Violet Irradiation

- Specific Wavelength
- Effective against viruses, bacteria, Cryptosporidium
- Expensive – electricity and bulbs
- Very high quality water
- No residual, so may need to chlorinate for residual
- Product Verification
  - Third party verification costs $50,000
  - None for small systems, yet

Ozone

- Gas – O3 – Generated on site
- Expensive
- Potentially hazardous and highly corrosive
- No THMs or HAA5s, only Bromate
- No residual
- Must use destructor for off gases

Chlorine Di-Oxide

- Generate on site
- Hazardous
- Very quick acting
- Very few THMs or HAA5s
- No Residual – reacts too quickly
- May need to chlorinate for residual
- Mostly large systems
- Often used to reduce DBPs
- Must monitor for chlorite

Which to Choose?

- Surface Water
  - Must chlorinate
  - May use others, too, for DBP control, etc.
- Groundwater
  - Chlorination is cheapest, gives residual
  - Others may be used at state approval but may require chlorination for residual

Groundwater Rule Disinfection

- Similar to Surface Water Treatment Rule so applies to all.
- 4 log reduction of viruses (99.99%)
- Ct greater than 1 (approximately 35 minutes contact time at 0.2 mg/l)
- Contact time based on time from Cl2 added to water until it reaches first tap. (Entering distribution syst.)
- Must be minimum of 0.2 mg/l at first tap
- Must be measurable residual at farthest point in system

Storage as Contact Time

- Elevated Storage Tanks – Standpipes = 0 minutes
- Regular unbaffled tanks – 10%
- Simple baffles – over inlet and outlet – 30%
- Baffle walls – Serpentine flow, etc. – 70%
- Plug flow – Pipes – 100%

- To increase storage for contact time
  - Can add or upgrade baffles
  - Most effective is serpentine, large diameter, main

Disinfection By-Products

- Applies to anyone that disinfects
- Chlorine
  - TTHMs and HAA5s
  - Ct calculations
  - Profiling
  - Benchmarking
- Ozone
  - Bromate
- Chlorine Di-Oxide
  - Chlorite

Total Tri-Halomethanes

- Chlorinated Organics
  - NOMs – Natural Organic Matter
  - Tannins, Leaves, Algae, Peat, Coal, etc.
  - Highest levels at end of the distribution system
- Mostly Carcinogenic
- Quarterly monitoring
- Four locations in Distribution system
- 4 Consectutive quarters, averaged, each location
- Each location must comply
- Operational Evaluation Levels

Halo-acetic Acids (5)

- NOMs
- Form immediately, then dissipate with Cl2 residual
- Highest level approximately near middle of system
- Carcinogenic
- Compliance calculated same as TTHMs
- May need IDSE – Initial Dist. Syst. Evaluation
  - Monitoring to find highest TTHM and HAA5
  - State usually waives for small GW systems
  - Low DBPs (1.2 MCL), <500 pop.

Profiling and Benchmarking

- Must achieve 1 log reduction for giardia or 4 log reduction for viruses, using EPA charts
- Weekly testing, graphed for each month, for one year (profile)
- End of year, lowest monthly average is benchmark
- Must test at highest daily flow
- Test for temperature, pH, chlorine residual, contact time using baffling factors
- Same day and time each week
- Any change to CL2 process must be profiled and benchmark must be no lower than original benchmark
- All Surface waters, and state determined GW.

Operational Evaluation Levels

- Used to determine potential DBP violations
- Average 1st, 2nd, 3rd, and 3rd quarter results
- If over MCL must write a report to state
  - Identify cause of problem
  - Identify potential solutions
  - Identify the course of action to bring levels down for 4th quarter

DBP creation and control

- Storage
  - Long retention times results in higher DBPs
  - During off seasons, partially fill tanks
- Dead end lines
  - Flush lines regularly
  - Loop distribution system
- High chlorine levels
  - Reduce chlorine residual (Profile must remain same)
  - pH adjustment
  - Alternative disinfectants – chloramines, ozone, ClO2

DBP creation and control (cont'.)

- High Organic Levels
  - Change source, watershed, point of diversion, etc.
  - Reduce levels through carbon addition, oxidation
  - Membranes
- Dirty Distribution System
  - Clean tanks
  - Flush system
  - Organic intrusion? Cross-connections? Breaks?
  - Super-chlorination
  - Materials – paints, plastics, etc.

Taste and Odor Control

- Too little chlorine to burn out all organics
- Inorganics, then organics
- Combined residuals are problematic
- Should operate in free residual range
- Breakpoint chlorination

Breakpoint Chlorination

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- Residual
  -
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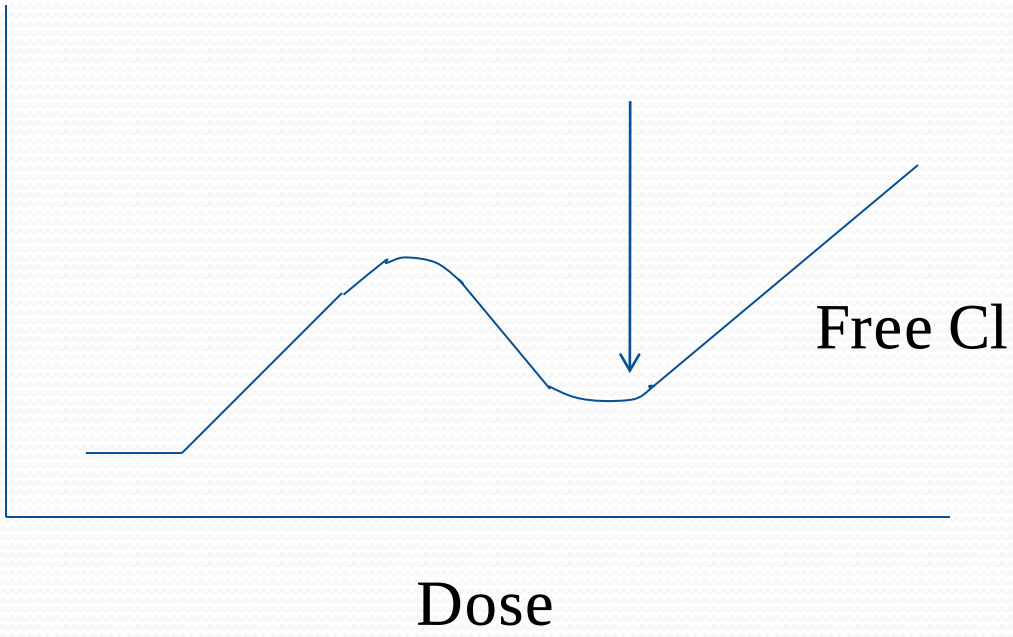

Useful Equations

- Chemical dosage MG/day x mg/l x 8.34 = #/day
  - Determine amount of chemical needed per day
  - Use to set chemical feeder
  - Divide by strength, use .05 for 5 % chlorine
- Concentration MG x mg/l x 8.34 = #
  - Use for volume such as storage tanks, disinfecting lines, mixing solutions, etc.
  - Divide by strength, use .05 for 5 % solution