

# Basic Water Treatment

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# Topics of Discussion

- Why is water treatment used?
- Considerations before installing treatment
- Disinfection
- Organics removal
- Iron and manganese removal
- Corrosion control treatment
- Treatment systems in combination
- General Water Treatment Guidelines
- ANSI/NSF Standards
- Classification of Water Treatment Plants

# Why is Water Treatment Used?

- To remove contaminants and achieve compliance with a Maximum Contaminant Level (MCL) thereby reducing health risk
  - Disinfection to kill or inactivate total coliform and/or E.coli bacteria
  - Organics removal with Granular Activated Carbon (GAC)

# Why is Water Treatment Used?

- To achieve aesthetic water quality standards
  - Sediment filters to remove suspended particles
  - Ion exchange water softener
  - Iron and manganese filtration
  - Taste and odor control using GAC

# Why is Water Treatment Used?

- For Corrosion Control
  - Calcite filtration for pH adjustment
  - Chemical injection for pH adjustment
  - Orthophosphate chemical injection

# Considerations Before Installing Treatment

- Type and concentration(s) of contaminant(s)
- Treatment options
- Initial cost of installing treatment equipment and ongoing costs of maintenance, chemicals, and additional water quality testing
- Available room to install treatment in existing pump house
- Submittal to DPH for review and approval prior to installation per RCSA Section 19-13-B102(d)(2)
- Having staff certified at the appropriate water treatment plant operator level or contracting with a certified treatment plant operator to maintain and operate the treatment system

# Chemical Disinfection

- Chlorination is used to inactivate bacteria that may be introduced into the water system
  - Correct well violations and deficiencies first
  - Eliminate cross connections within system piping first
- Regulations require a PWS to maintain a minimum chlorine residual of 0.2 mg/L after 10 minutes of contact time at the entry point (or more if trying to achieve 4-log removal in accordance with the GWR)
- Daily chlorine residual readings are required to be taken, recorded, and retained under RCOSA Section 19-13-B102(e)(7)(M)

# Chemical Injection Systems



# Chlorination Systems



## Advantages

- Destroys bacteria, viruses, and other pathogenic microorganisms
- Provides a barrier of protection throughout the system when adequate  $\text{Cl}_2$  residual is maintained
- Disinfectant residual can be monitored
- Can be used as an oxidant to suspend metals in solution for better filtration treatment performance
- Oxidizes hydrogen sulfide to reduce nuisance odor

# Chlorination Systems

## Disadvantages

- Chemical addition and disinfection by-products
- Requires a higher certified operator skill level
- Sufficient chlorine contact time required for effective disinfection
- More space required for contact tank and treatment system
- Disinfectant residual must be maintained and monitored on a daily basis
- Mineral oxidation may necessitate the need to install filtration treatment if raw water has mineral content.
  - Iron and/or Manganese common in groundwater

# What is this?



Contact tanks required to achieve adequate CT for sodium hypochlorite disinfection.

# Question

What is the chlorine residual requirement at the entry point?

A minimum of 0.2 mg/L after  
10 minutes of contact time

# Ultraviolet Disinfection

- May be considered for approval as a primary disinfection treatment if UV treatment guidelines are met
  - Source of supply is groundwater
  - Bacteria is documented to be coming from the groundwater source (not in distribution system)
  - UV unit meets ANSI/NSF 55 Standards
  - Raw water meets prerequisite water quality data

# Ultraviolet Disinfection



# Ultraviolet Disinfection

## Advantages

- No chemicals
- Instantaneous bacteria inactivation
- Closed system
- Low maintenance
- Can be installed in a relatively small space if pre-treatment is not necessary
- Relatively low initial and maintenance costs compared to chlorination systems

# Ultraviolet Disinfection

## Disadvantages

- No disinfectant residual
- Will only be effective if the bacteria source is entering the water system prior to the UV unit
- Pretreatment may be necessary for raw water with moderate to high mineral content
- May require units to be installed in parallel if water system cannot be shut down to allow for UV maintenance or replacement

# Question

What are some of the raw water minerals to be concerned of when considering a UV treatment system?

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<u>Parameter</u>	<u>Maximum Limit</u>
Color	15
Iron	0.3 mg/L
Manganese	0.05 mg/L
Hardness	120 mg/L
Hydrogen Sulfide	Non-Detectable
Suspended Solids	10 mg/L
Turbidity	1.0 NTU

# Organics Removal

## Treatment Options:

1. Granular Activated Carbon (GAC) filters –  
A Minimum of 2 filters in series
2. Aeration
3. Combination of GAC and Aeration

# Granular Activated Carbon (GAC)

- Used for removal of Organic Chemicals
- Used for taste & odor control
  - Chlorine removal
  - Sulfur odor (rotten egg smell)
- When used for Organics removal (VOC contamination), typically 2 units are installed in series

# What is this?

Air Stripper for VOC  
(organics) removal

What was wrong  
with this  
installation?



# Iron/Manganese Removal

- Water softeners are sometimes used
- Filtration is typically combined with pre-oxidation
  - Potassium permanganate
  - Chlorine
  - Air injection
- Manganese is typically oxidized at a higher pH therefore pH adjustment may be required

# Multiple Greensand Filters with GAC



# Question

What is the purpose of air injection or aeration in the treatment process?

- Oxidation
- VOC removal
- Radon removal
- pH adjustment

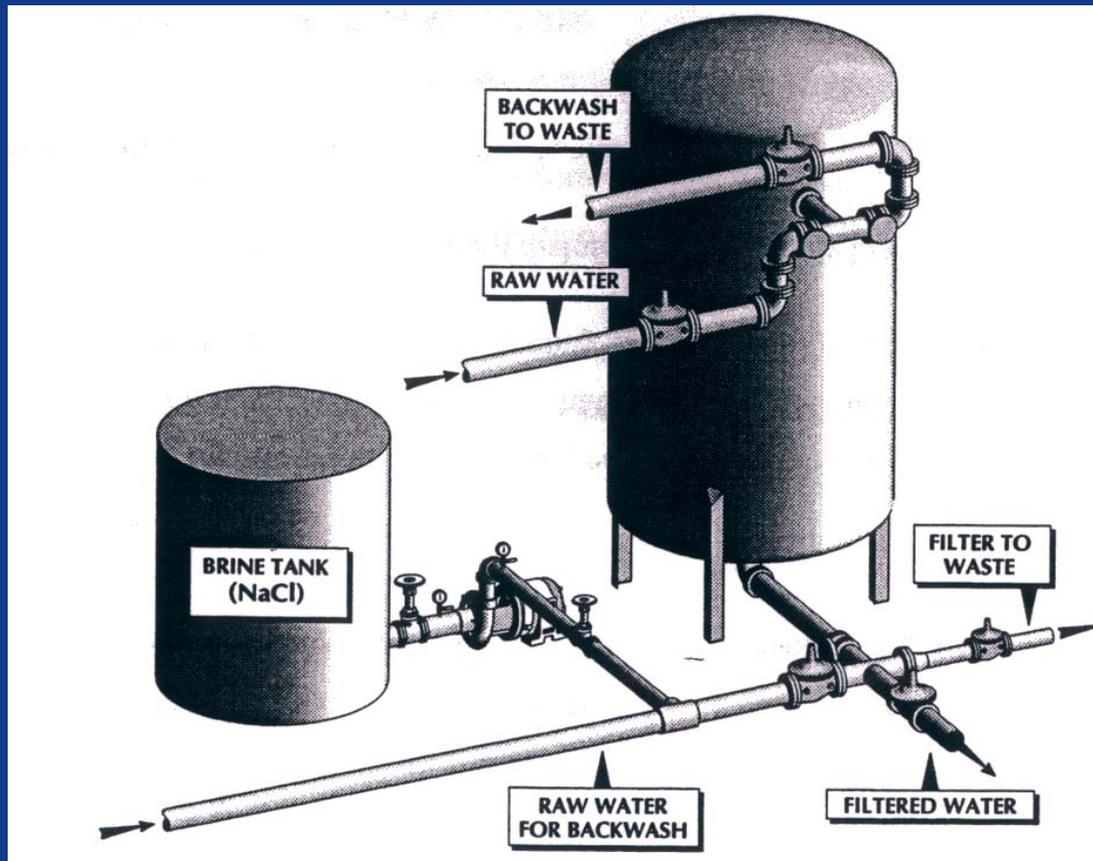
# Water Softeners

- AKA – Ion Exchange Units
- Used to remove hardness and/or iron and manganese
- Replaces Calcium and Magnesium ions in water with Sodium Ions
- Softener resin is regenerated with sodium ions from the brine solution

# Water Softener Regenerant

- Can be regenerated with sodium chloride or potassium chloride brine
- If sodium levels are already elevated, potassium chloride may be preferable
  - Sodium notification level is 28 mg/L
- Potassium chloride is more expensive than sodium chloride

# Ion Exchange Softening



National Environmental Training Association, Inc., Field Guide,  
III-6, 1999

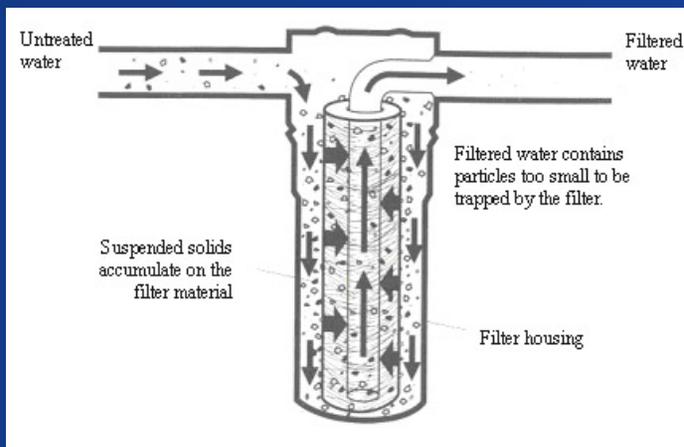
# Cartridge Sediment Filters

- Installed near pressure tank on many well water systems
- Used to remove silt, sediment, and other suspended matter
- Use as pre-filter for other treatment processes



# Cartridge Sediment Filters

- Sediment filter should be changed on a regular basis
- Spare filters should be kept in their original wrappings
- Wash hands before removing cartridge from sanitary wrapper and try not to allow hands to come into contact with filter
- Add a tablespoon of bleach to filter housing after filter replacement



# What is this?



Larger capacity sediment filter unit that can house one or more cartridge filters or bag filters.

# Question

What is one of the functions of a water softener in the treatment process?

- Hardness removal
- Iron and Manganese removal

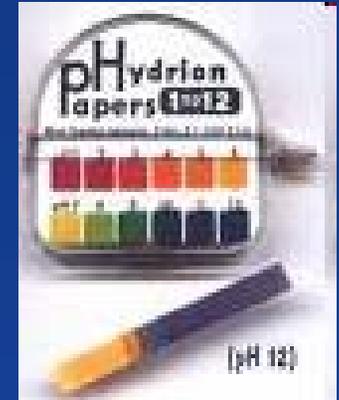
# Question

How can you tell when a cartridge from a sediment filter needs to be replaced?

- Low water pressure
- Visible discoloration in filter housing

# Corrosion Control Treatment

- pH adjustment
  - Calcite Filter
  - Chemical injection
- Introduction of corrosion control inhibitors
  - Calcite filters - protect scaling in pipes
  - Phosphate chemical injection - applies a protective layer on the pipes to help prevent corrosion



# Corrosion Control

- Evaluate the source Water Quality Parameters (WQP) results as part of the lead and copper rule monitoring requirements after an exceedance.
  - WQP – pH, alkalinity, calcium, conductivity, phosphate, temperature
- Based on the results, determine the treatment approach that is most effective.
- After installation of treatment, check WQP and saturation index at EP to confirm treatment effectiveness.

# pH Adjustment Calcite (Neutralizing) Filters

- AKA: acid neutralizers or limestone contactors
- Raise pH (typically not beyond 7.5)
- Adds hardness (calcium carbonate) and alkalinity which can be beneficial for corrosion control
- Calcite will dissolve over time therefore filter media needs to be replaced periodically (typically 6-12 months)
- Minimum weekly monitoring of pH level is required to be taken, recorded, and retained under RCOSA Section 19-13-B102(e)(7)(N)



# pH Adjustment Chemical Injection

- Can be done with carbonate (soda ash-sodium carbonate or other hydroxide products)
- Allows a range of pH level to be achieved
- More hazardous than a calcite filter
- Potential for chemical overfeed if chemical injection safety controls are not installed
  - Recommend injection paced proportionate to flow
- Daily monitoring of pH level is required to be taken, recorded, and retained under RCOSA Section 19-13-B102(e)(7)(N)



# Question

What are the monitoring requirements for the pH adjustment process?

- Calcite Filters - at least weekly pH readings
- Chemical injection – Daily pH readings

The readings must be recorded on the Treatment Effluent Log and submitted to [drinking.water@ct.gov](mailto:drinking.water@ct.gov) by the 9<sup>th</sup> day of the following month.

# Treatment Systems in Combination

- Calcite followed by a water softener
  - Used to remove iron and manganese
  - Calcite raises pH and facilitates manganese removal with the water softener
  - Calcite adds hardness and water softener reduces hardness
- Water softener followed by UV Treatment
  - Water softener reduces hardness, iron and manganese
  - Bacteria passing through UV unit is inactivated and does not “hide” under larger minerals
- Many other possible combinations





# General Water Treatment Guidelines

- Treatment shall be located in a well lit, clean, dry, ventilated, and sanitary environment
- Safety equipment for handling chemicals must be readily available
- Log books should be kept to document all maintenance actions and field test results
- A means to measure water flow must be provided in order to determine chemical feed rates
- Certified operator requirements for NTNC and CWS treatment plants

# Water Treatment Equipment Filtration

- Filters should be located for easy replacement/replenishment
- Sampling taps should be installed after each filter vessel to monitor water quality at each stage of treatment
- Filters should be serviced on a regularly scheduled interval
- All backwashing should be done with treated water
- Filters requiring backwash to on-site septic systems may require a discharge permit from the Dept. of Environmental Protection (DEP) if discharge is more than 500 gpd.



# Where does the backwash go?

- BACK WASH DISCHARGE MUST BE AIR-GAPPED
- Not in the septic system (definition of domestic sewage excludes treatment backwash)
- Technical standards say: "Oils, greases, industrial/commercial wastes, toxic chemicals and wastewater that is not sewage, as defined in Public Health Code Section 19-13-B103b (a), shall not be discharged to a subsurface sewage disposal system. Discharges of wastewaters from water treatment systems (e.g., water softeners, iron or manganese removal) to surface waters, sanitary sewer systems, subsurface sewage disposal systems or to the ground are prohibited unless otherwise authorized by the Department of Environmental Protection. A separate, dedicated disposal system shall be provided for any water treatment system wastewaters that discharge to the ground."





Is this an appropriate air gap?

**NO**



# What is wrong?



# What is wrong?

No air gap for BW  
discharges & storage tank  
drain



# Question

What kind of water should be used for backwashing?

Treated water

# What is the problem?



# What is the problem?

- contact tank leaking
- backwash with raw water
- tank back logged
- filter effectiveness



# Water Treatment Equipment Chemical Feed Equipment

- All chemical solution tanks (day tanks) should be equipped with tank level indicators, continuous agitators, vents to atmosphere, overlapping covers, and placed in containment basins. (note that all voids on the tank cover should be sealed to prevent the entrance of vermin.)
- Proper mixing and safety instructions should be available for maintenance personnel
- All chemical injection pumps must be controlled by an in-line flow sensor to prevent accidental overfeed in the case of a no-flow condition

# Water Treatment Equipment Chemical Feed Equipment (cont.)

- Chemical feed rates should be proportional to flow
- Chemical injection pumps may be automatically or manually controlled, with automatic controls being designed so as to allow override by manual controls
- Injection pumps should be of the positive displacement type and should be paced proportional to flow
- Install two chemical injection pumps, both with sufficient capacity to replace the largest unit during shut-downs

# Water Treatment Equipment Chemical Feed Equipment (cont.)

- Chemical injection pumps are installed as near as practical to the injection point
- A separate chemical injection pump shall be used for each chemical applied
- Spare parts shall be available for chemical injection pumps to replace parts which are subject to wear and damage
- Make-up water line to the chemical solution tank must have proper backflow prevention device installed
- Hoses used to provide make-up water should never be left in the chemical solution tank after replenishing even if a vacuum breaker is installed on the hose bibb

# What's Wrong?



- Day tanks maintained poorly
- Not all openings sealed
- Tanks not labeled

# ...Inside the Tank



# ANSI /NSF Standard 60 & 61

- NSF/ANSI Standard 60: Drinking Water Treatment Chemicals - Health Effects is the nationally recognized health effects standard for chemicals which are used to treat drinking water.
- NSF/ANSI Standard 61: Drinking Water System Components - Health Effects is the nationally recognized health effects standard for all devices, components and materials which contact drinking water.

# What's Wrong?



Over the counter bleach may not be NSF/ANSI certified!

# Other ANSI /NSF Standards

- **NSF/ANSI Standard 42:** Drinking Water Treatment Units - Aesthetic Effects
- **NSF/ANSI Standard 44:** Cation Exchange Water Softeners
- **NSF/ANSI Standard 53:** Drinking Water Treatment Units - Health Effects
- **NSF/ANSI Standard 55:** Ultraviolet Microbiological Water Treatment Systems
- **NSF/ANSI Standard 58:** Reverse Osmosis Drinking Water Treatment Systems
- Visit [www.nsf.org](http://www.nsf.org) for more information

# Questions

Is a backflow prevention device needed for the make up water line?

YES, if no air gap exists.

What NSF Standard should be applied to drinking water chemicals?

NSF Standard 60

# Classification of Water Treatment Plants and Small Water Systems

# Small Water Systems

- If the CPWS or NTNC serves less than 1,000 persons and either has no treatment or a treatment unit process that does not require any chemical treatment, process adjustment or media regeneration by an operator then the system is classified as a "SMALL WATER SYSTEM"

# “Passive Treatment” - Small Water System

- Treatment unit process that does not require any chemical treatment, process adjustment or media regeneration by an operator
  - UV Light
  - Calcite filter – media is replaced off site
  - Cartridge filter (whole house filter, sediment filter)
  - Exchange Softener – no backwash & media is regenerated off site
  - Granular Activated Carbon (taste & odor control)



# Water Treatment Plant Classification Form

Points Assigned for:

- Population Served
- Water Supply Source
- Chemical Treatment/Addition Process
- Coagulation & Flocculation Process
- Clarification/Sedimentation Process
- Filtration Process
- Other Treatment Processes
- Special Processes
- Residuals Disposal
- Facility Characteristics - Instrumentation



# Water Treatment Plant Classification Form

- Add up all the points and determine which level treatment plant applies

## TREATMENT PLANT LEVEL

- Class I                    30 points or less
  - Class II                    31 - 55 points
  - Class III                   56 - 75 points
  - Class IV                   76 points or greater
- 
- Available on the Drinking Water Section website:  
[www.ct.gov/dph/publicdrinkingwater](http://www.ct.gov/dph/publicdrinkingwater)



# Contact Information

Drinking Water Section

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