Disinfecting Your System

2013 Advance Small Water System Course
Reasons to Disinfect

Here is a recent example...

- Water system has *E. coli* positive routine distribution sample
- Drinking Water Services regulator contacted to discuss
- Boil water notice immediately provided to customers
- Contamination identified and removed, system disinfected and flushed
- Follow-up sampling verified problem was corrected
- Customers notified that drinking water is again safe
What System Components to Disinfect

• Source water (wells, springs)
• Storage facilities (reservoirs, pressure tanks)
• Distribution system piping
• New or repaired *wetted* system components (e.g. pipes, fittings, valves, pumps)
Why we Disinfect

To kill or inactivate pathogens (protozoa, bacteria and viruses) that may cause illness or effect human health.

- Types of contamination events that require disinfection
  - Total coliform or *E. coli* in distribution system
  - Total coliform or *E. coli* in source water

Adenovirus photo credit: [http://cronodon.com/](http://cronodon.com/)

E. coli photo credit: photobucket
How Disinfectants Work

- Disinfectants most commonly used are *oxidants*.
  - Oxidants take electrons in a chemical reaction.
  - This reaction inactivates bacteria or viruses.
  - A commonly used oxidant is chlorine (hypochlorite).
Events Requiring Well Disinfection

*Well Disinfection is recommended after:*

- Construction of a new well
- Maintenance activities (e.g. broken pipe repair)
- A positive coliform sample or other contamination event
- As a preventative measure to kill biofilm built up in the well casing
Determining the Correct Approach

• What level of disinfection should be achieved?
  – High level or “shock” chlorination
    o 50 mg/L for wells (target dose may vary for storage and distribution system applications)
  – Low level chlorination (< 4.0 mg/L, MRDL)
    o Service can be maintained during disinfection process
    o Good strategy when total coliform is only concern (no \textit{E. coli})

\textit{mg/L} = \text{milligrams per liter} = \text{ppm} = \text{parts per million}
\text{MRDL} = \text{maximum residual disinfectant level}
Disinfecting a Well
(Modified AWWA Standard C654-03)

- To determine the volume of water to disinfect you will need the *total depth* and *static water level* of the well.
- Determine the static water level by:
  - Taking a current measurement
  - Using a recent measurement
  - Using the well log
  - Use the total depth (worst-case)
  - *Note:* SWL can vary seasonally

```
Static Water Level = 35’
Total Well Depth = 100’
```
Measuring Static Water Level

- Borrow or rent equipment from:
  - Water Resources Department
  - Environmental consultants
  - Drillers
  - Laboratories

Oregon Department of Water Resources:
http://www.oregon.gov/owrd/gw/docs/water_level_booklet.pdf

Oregon State University Extension Service:
http://extension.oregonstate.edu/catalog/pdf/ec/ec1368.pdf
Measuring Static Water Level

Go very slow to avoid getting your water level meter stuck in the well
WATER WELL REPORT

STATE OF OREGON

(Do not write above this line)

WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date of well completion.

RECEIVED
AUG 6, 1979

WATER RESOURCES DEPT

(1) OWNER:

Name:

Address:

(2) TYPE OF WORK (check):

New Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL: ☐ Rotary ☐ Driven ☐ Domestic ☐ Industrial ☐ Municipal ☐

(4) PROPOSED USE (check):

☐ Table ☐ Jetted ☐ Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED:

☐ Threaded ☐ Welded

Diam. from ft. to ft. Gage

Diam. from ft. to ft. Gage

Diam. from ft. to ft. Gage

(5) PERFORATIONS:

Perforated? ☐ Yes ☐ No

Type of perforator used

Size of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

(10) LOCATION OF WELL:

County:

Jackson Driller's well number 61-79

1/4 1/4 Section 21A T. 36 R. 1W W.M.

Bearing and distance from section or subdivision corner

TAX LOT 400 AVE C 429TH WHITE CITY OR

(11) WATER LEVEL: Completed well.

Depth at which water was first found 69 ft.

Static level 10 ft. below land surface. Date 7-30-79

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing

Depth drilled 180 ft. Depth of completed well 180 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL From To SWL

SOIL-BROWN 0 3

CLAY-BROWN 3 16

W/GRAVEL 3 16

CLAY-BROWN 16 33
Searching for Well Log

http://apps.wrd.state.or.us/apps/gw/well_log/
Calculating Well Volume

- Determine well volume to be disinfected using the following formulas:

  Area (ft$^2$) = length (ft) x width (ft)
  Volume (ft$^3$) = area (ft$^2$) x h (ft)
  $V = 3.14 \times r^2 \times h$, or
  $V = d^2 \times 0.785 \times h$

Where:
- $r =$ Radius (ft)
- $d =$ Diameter (ft)
- $h =$ Height or Depth (ft)

Be sure all units of measure are the same
Calculating Well Volume

- The Well Disinfection Technical Bulletin on the Drinking Water Services website is also a good reference.

Disinfecting a Well
(Modified AWWA Standard C654-03)

- Example: determining depth of water to disinfect:
  - Total depth = 100 ft
  - Static water level = 35 ft
  - Depth to disinfect = X

\[
\text{Length} = 100 \text{ ft (total depth)} - 35 \text{ ft (SWL)} = 65 \text{ ft}
\]
Determining Volume to Disinfect

Example: You have a 6-inch diameter well that contains 65 feet of water. What is the volume in gallons?

Formula to use: \((\text{Length}) \times (\text{Gallons/foot of length}) = \text{Gallons in well}\)

\[
65 \text{ ft} \times 1.5 \text{ gal/ft} = 97.5 \text{ gallons of water in well}
\]
**Type of Chlorine to Use**

- **Sodium hypochlorite** (liquid)
  - Strength varies from 5% (household bleach) to 12.5%
- **Calcium hypochlorite** (dry powder/pellet)
  - Usually 45% strength
  - Used for deep wells & storage tanks
- **Avoid stabilized chlorine** (e.g. dichlor, trichlor) used for swimming pools and spas
NSF Standard 60

• The National Sanitation Foundation certifies products for use in public drinking water

• Look for NSF logo – Recommended but not required for shock chlorination if system is flushed before use

• Clorox® Regular Bleach and Clorox® Ultra Bleach meet NSF Standard 60 (no NSF logo on package but certified by WQA).


• When ordering chemicals ask for product that is safe for drinking water

• Go to [www.wqa.org/](http://www.wqa.org/) or other ANSI-accredited organizations to verify product as certified
Keep in mind:

• Chlorine loses its strength over time

• Bleach stored at about 70°F maintains the strength noted on the product label for about 3 to 5 months

Half life of 12.5% sodium hypochlorite at various temperatures

<table>
<thead>
<tr>
<th>Degrees F</th>
<th>Number of Days</th>
</tr>
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<tbody>
<tr>
<td>77°</td>
<td>220</td>
</tr>
<tr>
<td>87°</td>
<td>110</td>
</tr>
<tr>
<td>97°</td>
<td>55</td>
</tr>
<tr>
<td>107°</td>
<td>27</td>
</tr>
</tbody>
</table>
Safety Considerations When Using Chlorine

- Chlorine is a strong oxidant
- Highly corrosive
  - Especially at levels over 100 mg/L
- May cause skin and eye irritation or damage
- Use goggles and rubber gloves when handling
- Wear protective clothing (i.e. splash apron and rubber boots)
- Provide good ventilation when using. Remember, chlorine is heavier than air.
Calculating Chlorine Needed

- Wells are commonly chlorinated to achieve 50 mg/L for 12 - 24 hours
- Guideline – Target concentration of 50 mg/L equals about 1.6 cups of 5% bleach per 100 gallons of water
- Solution strength in “%” is not synonymous with mg/L
Calculating Chlorine Needed

Formula to determine amount of bleach needed:

\[
\text{(target concentration in mg/L)} \times \text{(volume to be disinfected in gal)} \times \text{(16 cups/gal)} = \text{(chlorine concentration as %)} \times \text{(10,000 mg/L/%)}
\]

- Target Concentration = 50 mg/L
- Volume = 97.5 gallons round up to 100 gallons
- Chlorine concentration = 5% (Note: product strength varies)
- Bleach amount = \( \frac{(50 \text{ mg/L})(100 \text{ gal})(16 \text{ cups/gal})}{(5\%)(10,000 \text{ mg/L/%})} \) = 1.6 cups
Calculating Chlorine Needed

Calculate amount of calcium hypochlorite needed (solid) =

Using the Pounds Formula:
(volume in MG) x (8.34 lb/gal) x (target concentration in mg/L)

- Volume = 5,000 gallons/1 million = 0.005 MG
- Target Concentration = 2 mg/L
- Available chlorine = 45% (or 0.45)
- Lbs of chlorine = \(\frac{(0.005\,\text{MG}) \times (8.34\,\text{lb/gal}) \times (2\,\text{mg/L})}{0.45}\)

= 0.185 lbs or 2.96 ounces

*Don’t forget to verify the available chlorine in product.*
Help with Conversions

Basics for Small Water Systems in Oregon

FACT SHEET 4.7 –
Basic Math: Common Calculations for Small Water Systems

<table>
<thead>
<tr>
<th>Abbreviations:</th>
<th></th>
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<tbody>
<tr>
<td>ft</td>
<td>Feet</td>
</tr>
<tr>
<td>gpd</td>
<td>gallons per day</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
</tr>
<tr>
<td>gpm</td>
<td>gallons per minute</td>
</tr>
<tr>
<td>MGD</td>
<td>million gallons per day</td>
</tr>
<tr>
<td>lb</td>
<td>pounds</td>
</tr>
<tr>
<td>mL</td>
<td>milliliter</td>
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<tr>
<td>L</td>
<td>liter</td>
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<table>
<thead>
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<th>Conversion Factors:</th>
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<tr>
<td>1 acre</td>
<td>= 43,560 square feet</td>
</tr>
<tr>
<td>1 acre foot</td>
<td>= 43,560 cubic feet</td>
</tr>
<tr>
<td>1 cubic foot</td>
<td>= 7.48 gallons</td>
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<tr>
<td>1 foot</td>
<td>= 0.305 meters</td>
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<tr>
<td>1 gallon</td>
<td>= 3.79 liters</td>
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<tr>
<td>1 gallon of water</td>
<td>= 8.34 pounds</td>
</tr>
<tr>
<td>1 horsepower</td>
<td>= 0.746 kilowatts</td>
</tr>
<tr>
<td>1 million gallons per day</td>
<td>= 694 gallons per minute</td>
</tr>
<tr>
<td>1 pound</td>
<td>= 0.454 kilograms (454 grams)</td>
</tr>
<tr>
<td>1 Liter</td>
<td>= 1000 mL</td>
</tr>
<tr>
<td>1 Liter of water</td>
<td>= 1000 grams</td>
</tr>
<tr>
<td>1 gram</td>
<td>= 1000 kg</td>
</tr>
<tr>
<td>1 pound per square inch (psi)</td>
<td>= 2.31 feet of water (head)</td>
</tr>
<tr>
<td>1%</td>
<td>= 10,000 mg/L</td>
</tr>
<tr>
<td>Degrees Celsius</td>
<td>= (Degrees Fahrenheit - 32) ( \times \frac{5}{9} )</td>
</tr>
<tr>
<td>Degrees Fahrenheit</td>
<td>= (Degrees Celsius) ( \times \frac{9}{5} ) + 32</td>
</tr>
<tr>
<td>( \pi )</td>
<td>= 3.14</td>
</tr>
</tbody>
</table>
Online Conversion Tools

- Use any number of online conversion tools by doing a search on “unit conversion”, or
- Type the value to be converted into the Google search bar (e.g., “25 tablespoons to cups” yields a result of “25 US tablespoons = 1.5625 US cups”).

![Google Unit Conversion Example](image)
How to Measure Higher Concentrations

*Using Dilution Method*

1. Achieve target of **50 mg/L** chlorine solution in a 5 gallon bucket
2. Cut solution to 1:25 to get to **2 mg/L** (mid-range of chlorine colorimeter)
3. 1 Tbsp:25 Tbsp = **1 Tbsp solution to 1.5 cups + 1 Tbsp water**
Chlorine Sampling Methods

- DPD (or other EPA approved) method required unless doing gross evaluation of chlorine levels
- Know instrument ranges
- Verify equipment can be calibration
- Beware of fading color wheels

Drinking water approved methods

Unapproved methods for drinking water

Restaurant inspector’s tape
High Dosage Considerations

- Adding excessive amounts of chlorine to a well is not a good idea
- Raises pH which lowers chlorine effectiveness
- Take too long to flush out
- Can damage/corrode equipment
- Disposal can be difficult
  - Safety considerations
  - Hazardous to wildlife
Disposal of Chlorinated Water

- DEQ has requirements discharging super-chlorinated water (above 4 mg/L total chlorine residual)
- Regardless of volume, super-chlorinated water **must not be discharged to surface waters or storm sewers**.
- Non-discharge alternatives:
  - sanitary sewer disposal (either by connecting to a sanitary sewer or by hauling to a sewage treatment plant)
  - Land disposal or irrigation.
- Discharging chlorinated water into on-site septic systems can cause damage by inactivate microbes

**DEQ Memorandum & Decision Matrix on Chlorinated Water Discharges:**

[http://www.deq.state.or.us/wq/pubs/bmps/chlorwaterdisp.pdf](http://www.deq.state.or.us/wq/pubs/bmps/chlorwaterdisp.pdf)
Water System Disinfection

What components will require disinfection?

**Scenario 1:**
- Well
- Storage Tank
- Distribution System

**Scenario 2:**
- Well A
- Well B
- Distribution System
- Storage Tank
Water System Disinfection

What components will require disinfection?

Scenario 3:

- Well A
- Storage B
- Storage A
- Distribution System
- Well C
- Well B
Well Chlorination

Option 1 – “Bottom Up Injection”

1. Ideal method to achieve 50 mg/L throughout water column
2. Run tube into casing to bottom of well
3. Withdraw tube while injecting chlorine solution

Option 2 – “Down-Hole Method”

1. If bottom-up injection method is not feasible, dilute chlorine into at least 5 gallons of (warm) water and mix
2. Make sure chlorine mixes thoroughly with dilution water
3. Pour into well with a funnel through a plug or casing vent hole at the top of the sanitary seal
Disinfecting through Well Caps

- Three common types of well caps:
  - *Turtle Back* with access plug
  - *Turtle Back* without access plug
  - Sanitary well cap
- You will need the right tools to unbolt the well cap.
- Be careful with exposed wiring to prevent damage.
Well Chlorination

4. To mix solution within well, attach a hose to nearest downstream tap (before any unpressurized storage tanks).

5. **Recirculate** water from tap back into well for at least 15 minutes. *Note:* When restricting pump’s outflow to one hose (during recirculation), back pressure on pump could cause damage or trip it off. If necessary, use a buffer tank and siphon it back into well in batches.

6. Verify target dose and let mixed disinfectant remain in the well for 12-24 hours.

7. Flush by using a flow splitter and re-circulate half the water down the casing while pumping half to waste until no chlorine is detected. Be sure to flush inside well casing and other internal components to prevent corrosion.
Example of how to recirculation water down a well

http://infohouse.p2ric.org/ref/20/19703.htm#SHOCKCHLORINATE
Steps After Flushing

8. Pump to waste for 15 minutes after verifying zero chlorine residual.

9. Collect at least 2 coliform samples a minimum of 30 minutes apart.

10. If samples are positive, pump to waste for another 15 minutes and collect at least 2 more samples a minimum of 30 minutes apart.

11. If samples are still positive, repeat chlorination and retest or take other corrective action in consultation with a well professional.

Note: For newly constructed wells, use solution strengths of up to 100 mg/L for 24 hours (AWWA Standard A100-06)
Water System Disinfection

- Wells, storage tanks and piping may need to be disinfected independently.
- Coordinate timing for storage and distribution system disinfection.
- Calculate volume of water in storage or use tank dimensions.

**Rectangular Tank Volume Formula:**

\[ V \text{ (gal)} = L \text{ (ft)} \times W \text{ (ft)} \times H \text{ (ft)} \times 7.48 \text{ gal/ft}^3 \]

- For H, use height to overflow
- To be conservative use total height

**Cylindrical Tank Formula:**

\[ V \text{ (gal)} = d^2 \text{ (ft)} \times 0.785 \times H \text{ (ft)} \times 7.48 \text{ gal/ft}^3 \]

- Can also use formula \( V = 3.14 \times r^2 \times h \)
Calculating Volume of Rectangular Basin

Example 1: 60’ long, by 40’ wide, by 10’ deep (at overflow).
What is the total volume this reservoir can hold in cubic feet?

Formula: \( V = L \times W \times H \)

\[
60' \times 40' \times 10' = 24,000 \text{ ft}^3
\]

Convert cubic feet to gallons:

\[
24,000 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 179,520 \text{ gal (round to 180,000 gal)}
\]
Calculating Volume of Cylindrical Basin

Example 2: A tank has a diameter of 40 feet and is 10 feet deep at the overflow. How many gallons can the tank hold?

Calculate the volume:
\[ d^2 \times 0.785 \times h = \text{Volume (ft}^3\text{)} \]

\[ 40' \times 40' \times 0.785 \times 10' = 12,560 \text{ ft}^3 \]

Convert cubic feet to gallons:
\[ 12,560 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 93,949 \text{ gallons} \]
Reservoir Chlorination

- Determine timeframe (*method exposure time*) using AWWA exposure timeframes of 3, 6, and 24 hours.
- Method exposure time depends on chlorine concentration and whether chlorine can be added simultaneously with reservoir filling to improve mixing.
- Combining time and concentration is referred to as a *method* (Per the AWWA Standard C652-02)
- Longer exposure times are more conservative and may improve disinfection.
Reservoir Chlorination Tool

Basics for Small Water Systems In Oregon:
Storage Tank Chlorination

Disinfection concentrations and times are based on AWWA Standard C652 for storage tanks cited in: OAR 333-061-0050 "Construction Standards" (10)(d) dated 19 Apr 2010, page 297

Question: How much chlorine is added to a tank?

Volume to be disinfected = 500 gallons

Options for Disinfection by Chlorination:
Method A. Filling the tank or reservoir with a 10 mg/L chlorine solution and allowing it to remain for 6 or 24 hours (see Table).
Method B. Filling the reservoir with a 50 mg/L chlorine solution and allowing it to stand for 6 hours (see Table).
Method C. Spraying or brushing on a 200 mg/L chlorine solution and allowing it to remain for 3 hours (calculation not provided).

<table>
<thead>
<tr>
<th>Chlorination Dose for Storage Tank of Volume Specified Above</th>
<th>Method A</th>
<th>Method B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine Concentration</td>
<td>10 mg/L</td>
<td>50 mg/L</td>
</tr>
<tr>
<td>Method Exposure Time</td>
<td>6 or 24 hours</td>
<td>6 hours</td>
</tr>
<tr>
<td>Chlorine Source Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleach 5% Solution</td>
<td>0.10 gallons</td>
<td>0.50 gallons</td>
</tr>
<tr>
<td>Bleach 12.5% Solution</td>
<td>0.04 gallons</td>
<td>0.20 gallons</td>
</tr>
<tr>
<td>Dry Chlorine (65% by wt)</td>
<td>0.06 pounds</td>
<td>0.32 pounds</td>
</tr>
<tr>
<td></td>
<td>0.023 kilograms</td>
<td>0.147 kilograms</td>
</tr>
</tbody>
</table>

(Chlorine Concentration values [yellow, or grey, cells] can be changed for custom calculations)

→ Note that to achieve Method concentration, add more chlorine than specified here.

Important: The chlorine concentration should be measured to confirm Method's target concentration is reached. May need to dilute sample to test kit range.

1. Enter *Volume to be disinfected.*
2. *Chlorine Source Material* values automatically change to achieve target chlorine dose based on volume entered.
3. Chlorine concentrations are also calculated as a function of *method.*
4. Amount of chlorine material needed is in red text.
Reservoir Chlorination Tool

- The target dose is either 10 or 50 mg/L, unless the method is spray application at 200 mg/L.
- Wait the full duration of method disinfection time listed in the spreadsheet.

### Chlorination Dose for Storage Tank of Volume Specified Above

<table>
<thead>
<tr>
<th>Chlorine Concentration</th>
<th>Method A</th>
<th>Method B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>50</td>
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<table>
<thead>
<tr>
<th>Method Exposure Time</th>
<th>6 hours</th>
<th>24 hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>6 hours</td>
<td>6 hours</td>
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</table>

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<tr>
<th>Chlorine Source Material</th>
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<td>0.32</td>
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</table>

### Options for Disinfection by Chlorination:

- **Method A**: Filling the tank or reservoir with a 10 mg/L chlorine solution and allowing it to remain for 6 hours or 24 hours (see Table).
- **Method B**: Filling the reservoir with a 50 mg/L chlorine solution and allowing it to stand for 6 hours (see Table).
- **Method C**: Spraying or brushing on a 200 mg/L chlorine solution and allowing it to remain for 3 hours (calculation not provided).
Reservoir Chlorination Example

- The reservoir water volume is 10,000 gallons and there is no other storage.
- The target dose is 50 mg/L and a 6-hour time frame will be used (Method B) to minimize service interruption.
- How much normal (5%) household bleach is needed to disinfect the reservoir?

**Answer:**

Add 10 gallons of normal household (5%) bleach to the reservoir and mix by recirculating. Measure the chlorine concentration. If the solution mixed in tank measures a bit low (e.g. 45 mg/L), add about 10% of original dose, or 1 gallon of bleach and mix again. If concentration is now > than 50 mg/L, start clock on the 6-hour interval.
Reservoir and Distribution Chlorination

1. Flush storage volume through distribution until chlorine concentration is achieved and detected at distribution taps.

2. Once contact time has been achieved in distribution (12-24 hours) begin flushing entire system.

3. Flushing may need to occur in multiple phases depending on source yield and distribution volume (refilling storage with hauled water may be necessary).

4. After zero chlorine residual is detected at all distribution taps, collect a representative number of coliform samples using sites designated in the coliform sampling plan.

5. Repeat disinfection process as necessary if any samples are coliform positive.
Water System Disinfection

Low Level Chlorination

- This method may be a good choice if bacteria levels (total coliform only) are thought to be low, and/or it is important to maintain service during the disinfection process.
- Chlorine residual must be kept below 4.0 mg/L – maximum for human consumption (MRDL).
- The amount of time to maintain chlorine level is an estimation.
- The procedure may not work if there is extensive bacteria and/or biofilm. It may not be enough to break through biofilm protecting bacteria growth.
- Mechanics: A continuous feed pump is ideal, batch dosing into a storage tank can work with consistent application and good math.

**Frequent chlorine monitoring in distribution is critical!**
Potential Disinfection Complications

• The process is not an exact science.
• Dosing calculations address a worst case scenario. Chlorination may not even be needed.
• There is no way to know the extent of bacteria colonization. Heterotrophic plate counts (HPC) can help determine this.
• **High-volume (unidirectional) flushing** alone may solve the problem.
• Each situation may have mechanical and electrical challenges:
  – Overloading well pumps
  – Overriding storage tank float switches
  – Inadequate taps and valves for effective recirculation
  – Other issues?
Class Exercise (Part 1):
Calculate system volumes for your water system

Determine well, storage, & distribution pipe volumes

Shock Chlorination Worksheet

Water System Name: ________________________________

Well disinfection
Casing Diameter (in) __________________

Total well Depth _______ ft minus Static Water Level _______ ft = Well water depth _______ ft

Gallons in well = Depth of water (ft) X Gallons per foot of depth (based on table with casing diameter)
= _______ x = _______ gallons of water to be treated in well

How much bleach product would you need to add to the well to achieve at least 50 ppm? (Use excel form or this formula)

Cups of bleach product = (target concn. ppm) / (water vol., gal) x (16 cups/gal)
(Bleach concentration as %10,000 ppm)
= 50 ppm x ___ gals in well x 16
___ % bleach product x 10,000
= ___ cups

(Also, remember the rule of thumb of approximately 1 cup of 5% bleach per 100 gallons to get 50 ppm.)

Storage Tank
Same question, to achieve 50 ppm in the storage tank you would need...

Gallons to be disinfected in tank: __________

Gallons of bleach product = 50 ppm x ___ gals in tank
___ % bleach product x 10,000
= ___ gallons bleach product

Distribution System
Disinfect pipes to achieve 50 ppm...

1. Length of pipe (L) from point of disinfection to first user: ______ feet
2. Diameter of pipe (D) between point of disinfection and first user: ______ inches
3. Volume of pipe (V1) = (L X D^2) / 4 = 24.5 or (L X D X D) / 4 = 24.5 or
   (L X D X D X D) / 4 = 24.5 = ______ gallons
4. Repeat calculations if additional lengths of pipe
   Volume of pipe (V2) = (L X D^2 X D) / 4 = 24.5 = ______ gallons
5. Total Volume of pipes (Vtotal) = V1 + V2 + ... = ______ gallons
6. Gallons of bleach product = 50 ppm x ___ gals in tank, or multiply by 16 to get ___ cups
   ___ % bleach product x 10,000

PUBLIC HEALTH DIVISION
Center For Health Protection, Drinking Water Services
Class Exercise (Part 2):
Design Your Own Disinfection Process

1. Determine chlorine amount needed based on your system’s volume.
2. Develop a strategy in steps (e.g. add chlorine to well and then batch dose from the reservoir into distribution, etc.).
3. Plan the public notification process.
   - Customers must be informed of timelines and water use restrictions to protect their health.
   - Dishes and household cleaning are about the only things you can do with shock chlorinated water.
   - Notify customers when it’s all over.
4. Document chlorination events.
   - What worked and ways to improve the process
Helpful Links

• **How to disinfect a well:**

• **Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation:**

• **Basics for Small Water Systems in Oregon**

• **American Water Works Association:** http://www.awwa.org/
Resources Available on DWS Website

Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation

Introduction

This Web page focus on assisting water system operators in utilizing the shock chlorination procedure, including the Shock Chlorination Calculation tool (xls), for disinfecting drinking water storage facilities. For more information about this procedure, please contact Drinking Water Services (DWS).

- Shock chlorination is a procedure used whenever there is a need for emergency disinfection of tanks, wells and/or distribution systems where there is confirmed evidence of microbiological contamination (i.e., positive coliform or E. coli (pdf) samples). Again, this procedure is for emergency purposes only and should not be used on a regular basis.

- See the DWS Well Disinfection (pdf) technical bulletin for shock chlorinating a well and small distribution system (no storage tank).

- Shock chlorination of a storage tank or reservoir consists of the following steps:
  1. Calculate tank water volume
  2. Determine the time frame or "Method Exposure"
  3. Add the correct amount of bleach using the Shock Chlorination Calculation tool (xls)
  4. Wait for disinfection to occur

More Resources

Drinking Water Data Online
Site Map
For Consumers
Contact Us

Drinking Water Services
Center for Health Protection
Questions & Discussion