



Chlorine Disinfection and CT Calculations

Tuesday, September 15, 2026 (1:00 to 2:00 pm EST)

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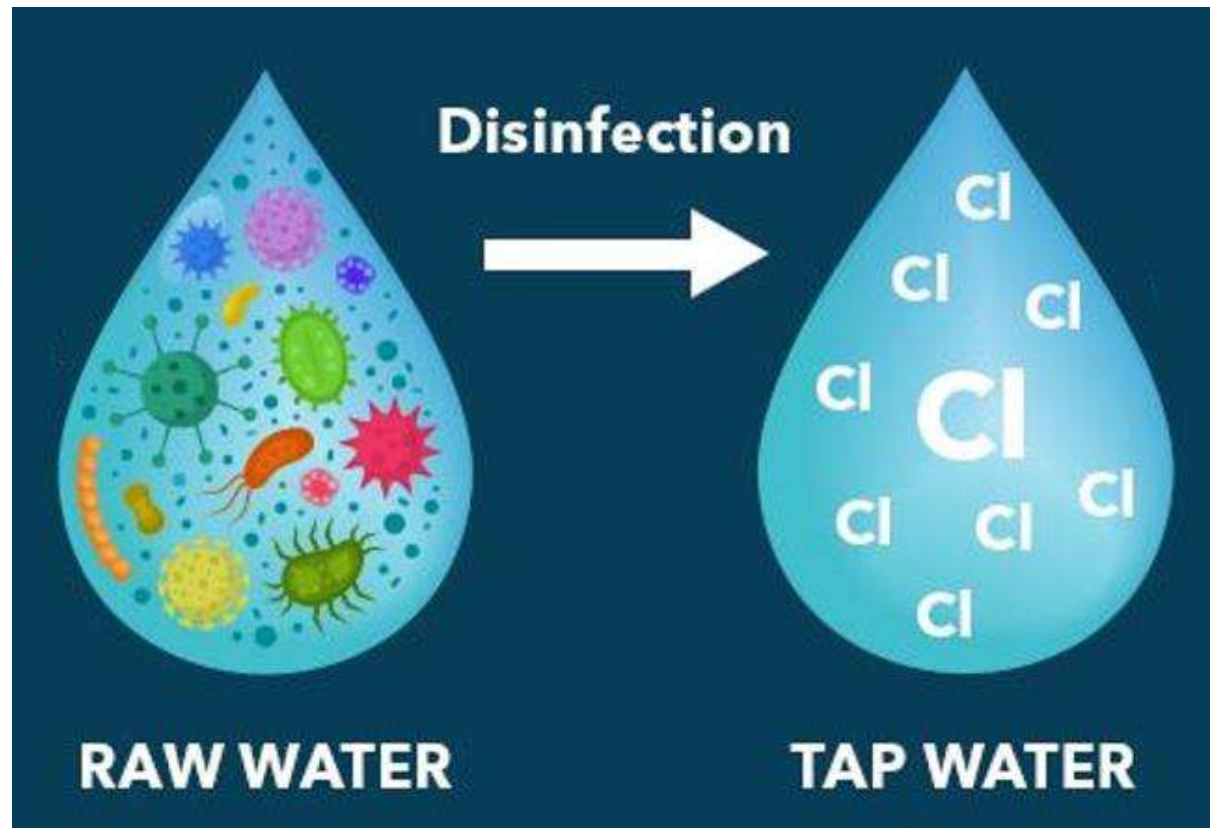
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This program is made possible under a cooperative agreement with US EPA.

Disinfection

The **inactivation** or **destruction** of pathogenic organisms in drinking water to protect public health

Primary disinfection is a critical part of the treatment process

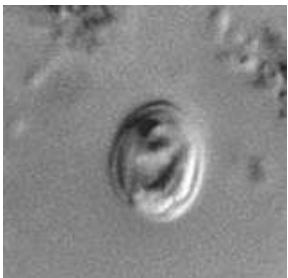


Disinfection Overview

The effectiveness of disinfection depends primarily on:

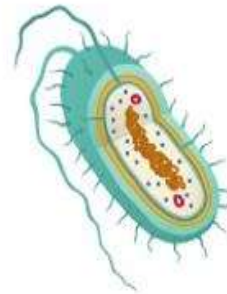
1. Residual concentration
2. Contact time

(Other factors include pH, turbidity, temperature, & reducing compounds)

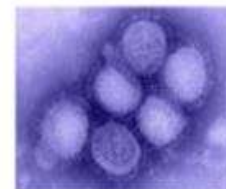


Cryptosporidium is a protozoan found in water sources in a cyst form where the organism is encased in a protective shell which is impervious to chlorine disinfection

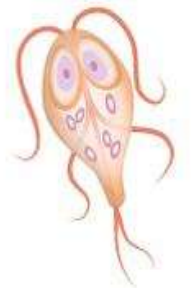
Pathogen Groups



E. coli
Bacterium



Influenza virus
Virus



Giardia
Protozoan

Common Primary Disinfectants

Chlorine

Effective disinfectant for killing bacteria, and inactivating viruses and most protozoa given sufficient concentration and time. Has a lasting residual.

Not effective against cryptosporidium and can produce disinfection byproducts.

Ozone

Created by passing oxygen through an electrical discharge which converts O₂ molecules to O₃. A powerful oxidizer and disinfectant that kills bacteria, viruses, and protozoa.

The residual only lasts 8 - 20 minutes, can produce the disinfection byproduct (bromate) with water containing bromide.

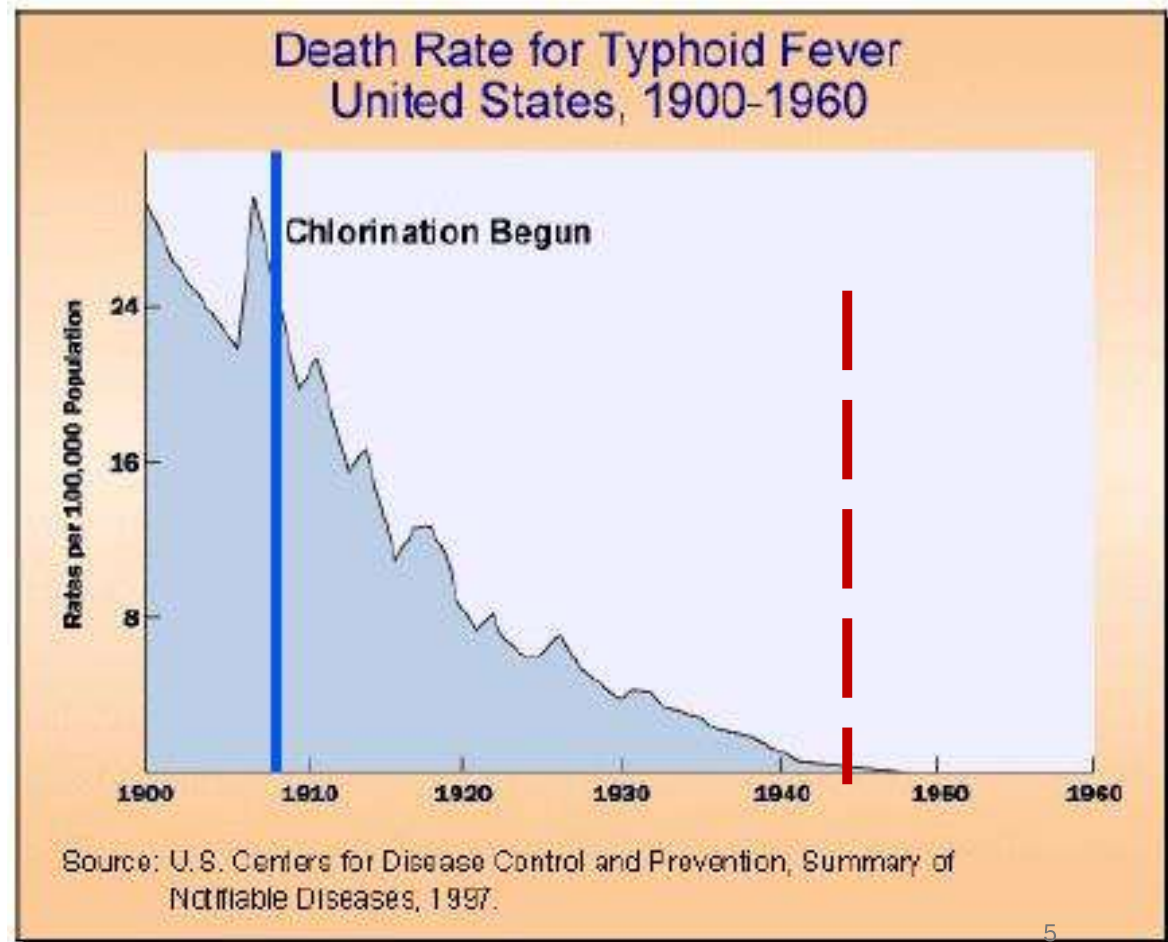
UV light

UV light with a wavelength of 254 nm kills pathogens.

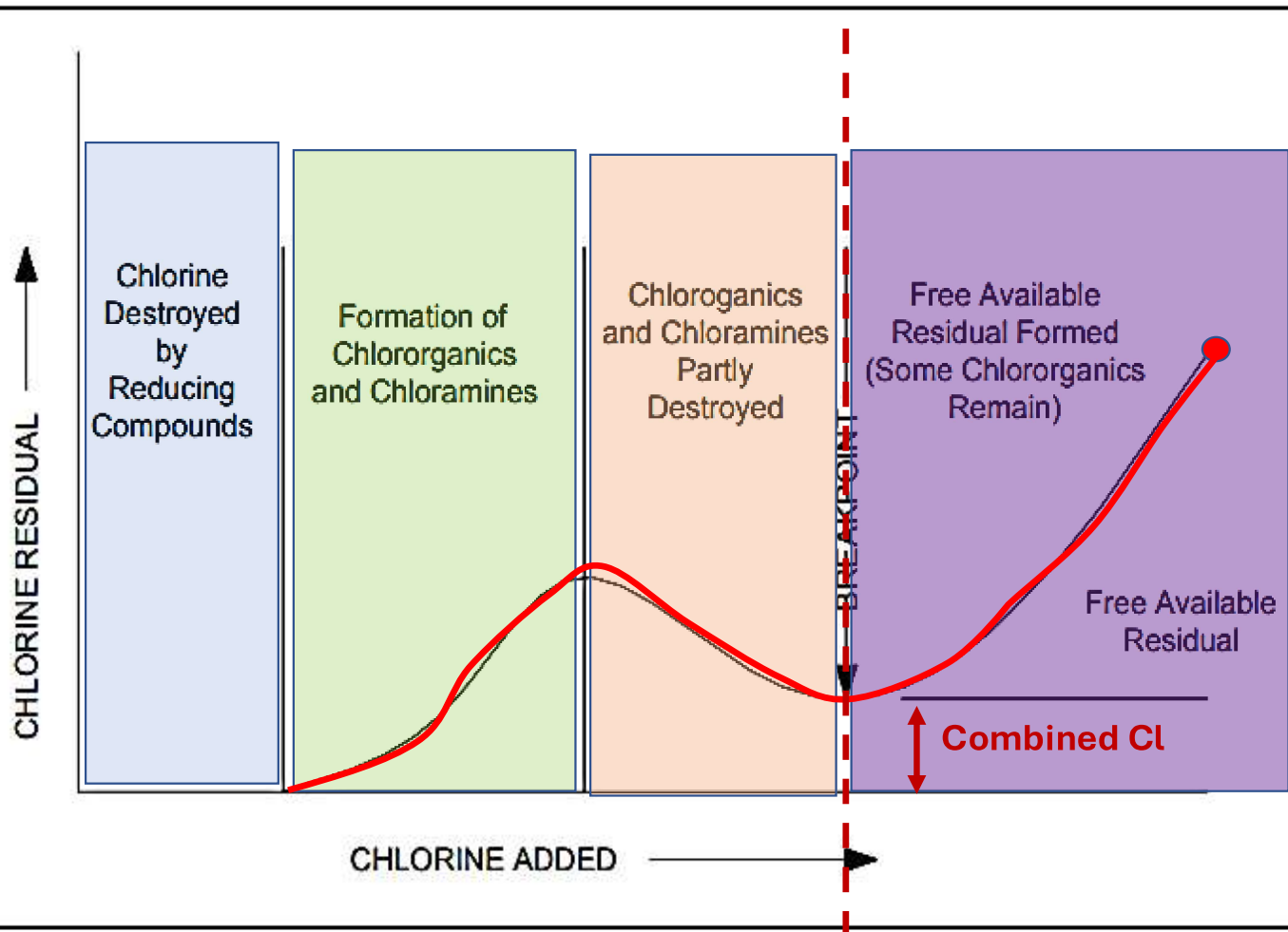
However, disinfection only occurs in the unit, water must be very clean, and there is no residual.

Health Impact of Chlorine Disinfection

- 1,000s of deaths due to water borne diseases - but no one understood the cause
- 1670s Antonie van Leeuwenhoek first observes microbes using a microscope
- 1854 John Snow figured out that cholera was a cause of a waterborne disease epidemic (cholera)
- 1860s Germ Theory developed by Louis Pasteur (microbes cause disease)
- 1908 Jersey City, NJ - first system in US to chlorinate drinking water
- The US water industry achieves less than 1 death per 100,000 around 1945



Chlorine Curve (total residual as chlorine is added)



Legend:

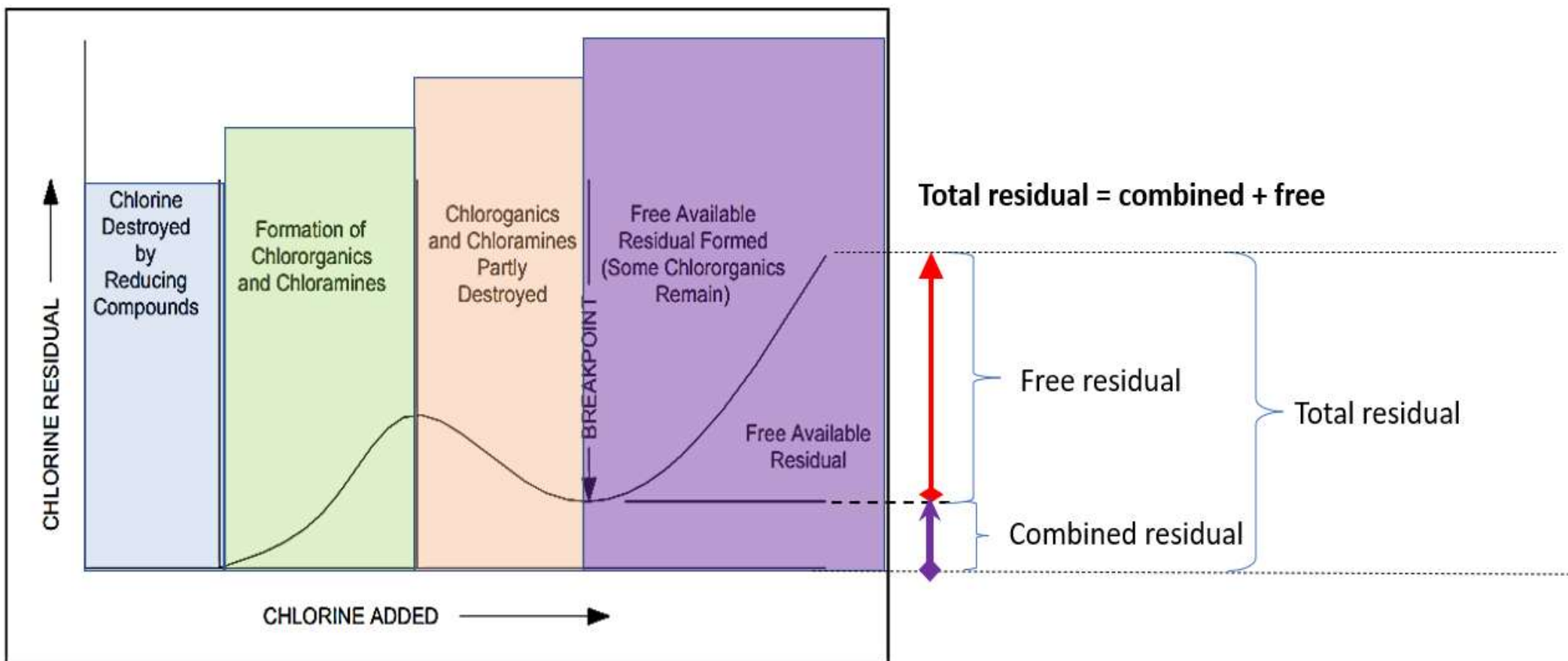
A: Reducing compounds use up chlorine.

B: Chloramines produced (combined chlorine).

C: Chloramines partly destroyed (also di and trichloramines produced).

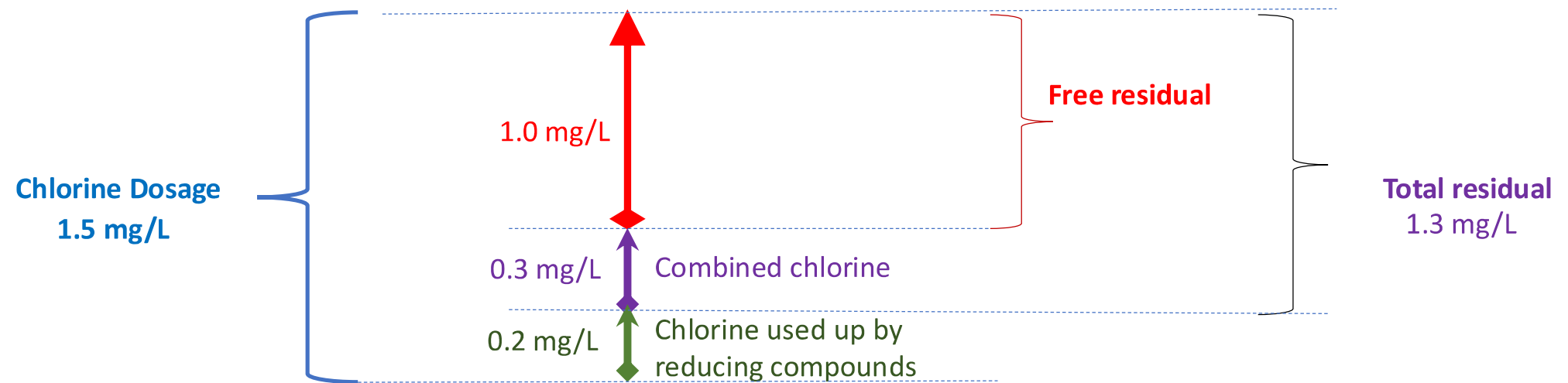
----- Breakpoint -----

D: After “breakpoint” free residual begins to build.



Dose = Demand + Residual

A dose of 1.5 mg/L chlorine is added to water resulting in a measured free residual of 1.0 mg/L and a total residual of 1.3 mg/L. **What is the demand from reducing compounds?**



How do we find the demand? (**Dose** – **total residual**)

$$1.5 \text{ mg/L} - 1.3 \text{ mg/L} = 0.2 \text{ mg/L demand}$$

$$1.5 \text{ mg/L} = 1.0 \text{ mg/L free residual} + 0.3 \text{ mg/L combined} + 0.2 \text{ mg/L demand}$$

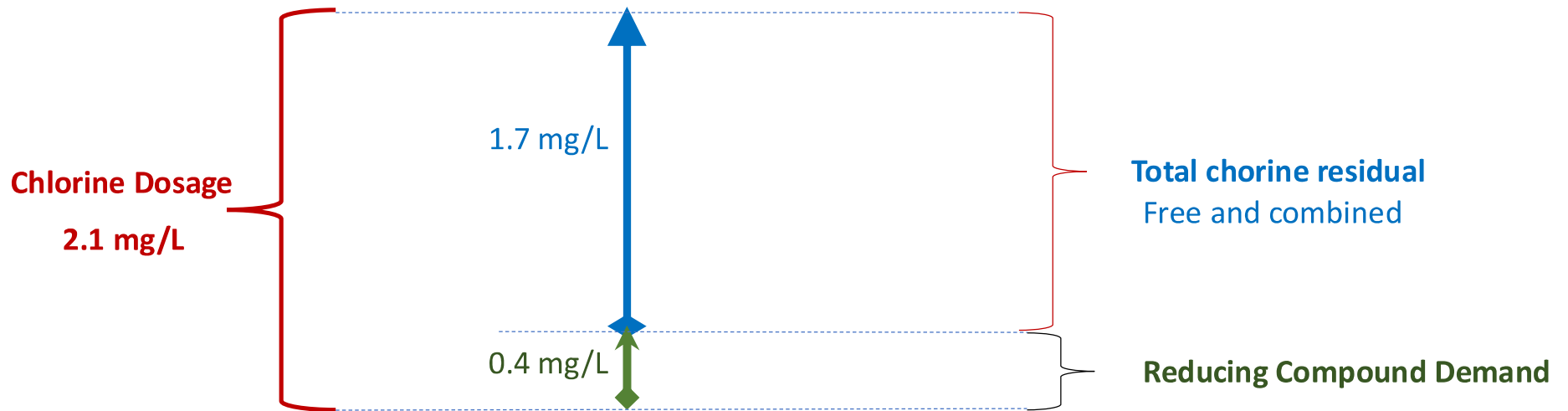
Poll #1

A drinking water with a demand of 0.4 mg/L has a total chlorine residual of 1.7 mg/L. What was the chlorine dose?

- a. 1.3 mg/L
- b. 1.4. mg/L
- c. 2.1 mg/L
- d. 5.7 mg/L



Dose = Residual + Demand

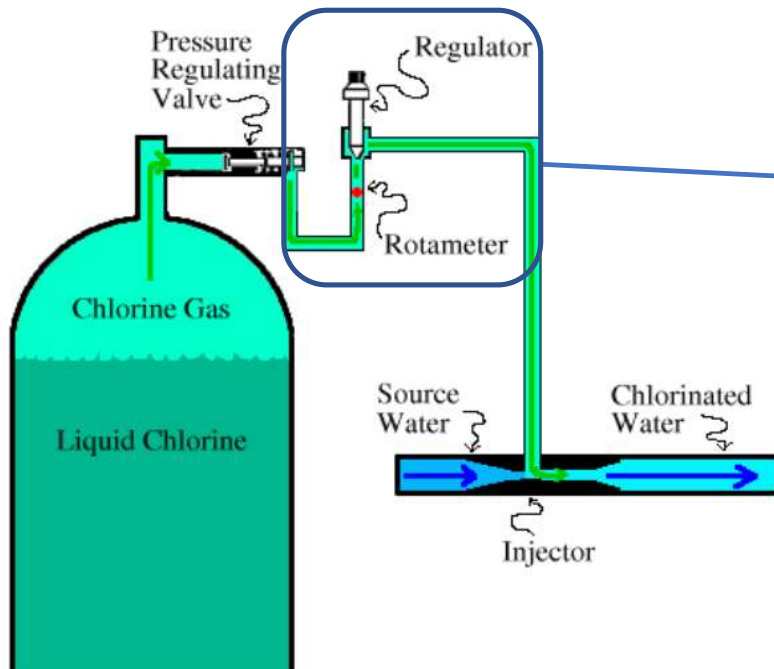


$$\text{Dose} = 0.4 \text{ mg/L demand} + 1.7 \text{ mg/L total residual} = 2.1 \text{ mg/L}$$

Gas Chlorine Feed Rate

$$\text{Pounds per Day} = \text{MGD}(\text{flow}) \times \text{mg/L}(\text{dose}) \times 8.34 \text{ lbs/gallon}$$

Note that pounds per day is a **rate** of feed.



Rotameter will provide units in lbs/day

Up to approximately 40 lbs/day

What is the feed rate setting for chlorine gas in lbs/day if the plant flow is **1.2 MGD** and the dosage concentration is **1.5 mg/L**?

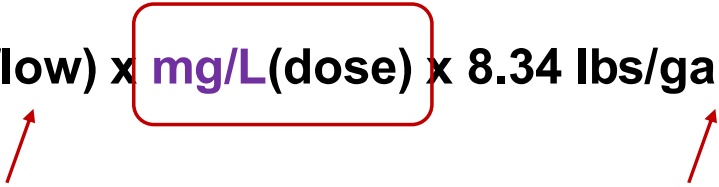
Solution: Plug in 1.2 MGD for flow, and 1.5 mg/L for dosage into the formula. Remember, the constant 8.34lbs/gal does not change.

Chlorine Feed in lbs/day =

$$\mathbf{1.2\ MGD \times 1.5\ mg/L \times 8.34\ lbs./gal = 15\ lbs./day}$$



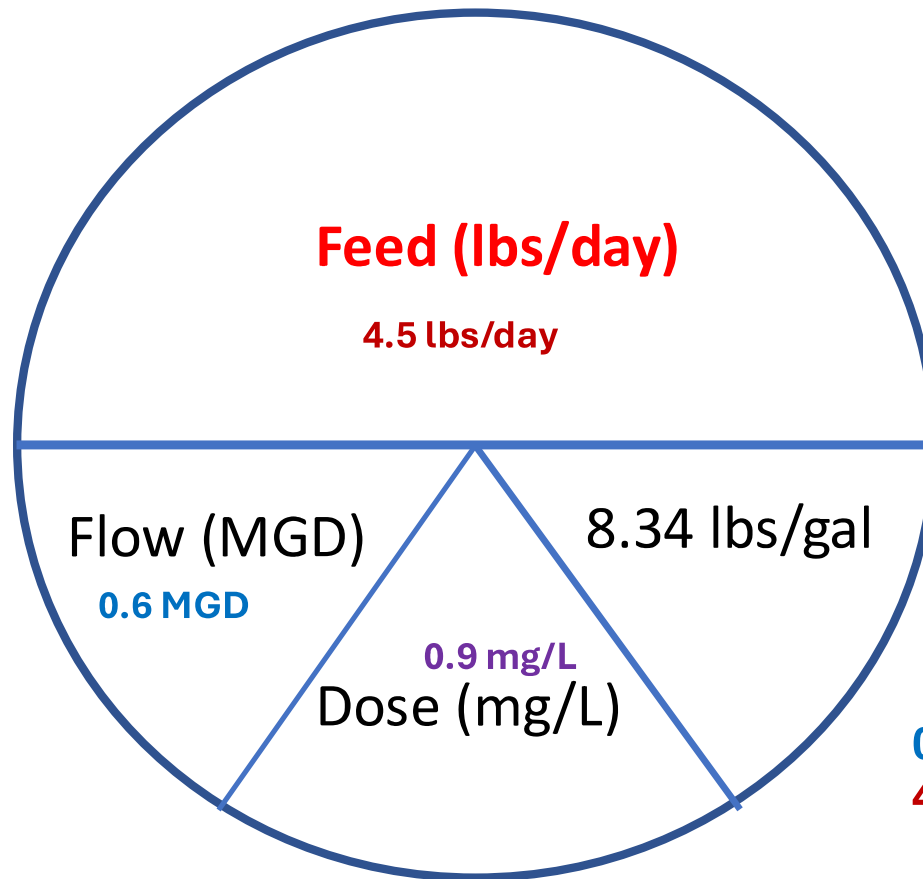
Pounds Formula Can Be Arranged To Solve For Dose:

$$\text{Pounds per Day} = \text{MGD}(\text{flow}) \times \text{mg/L}(\text{dose}) \times 8.34 \text{ lbs/gallon}$$


$$\frac{\text{Pounds per day}}{[\text{Flow}(\text{MGD}) \times 8.34 \text{ lb/gal}]} = \frac{\text{Dose (mg/L)} \times \text{Flow (MGD)} \times 8.34 \text{ lbs./gal}}{[\text{Flow (MGD)} \times 8.34 \text{ lb/gal}]}$$

$$\text{Dose (mg/L)} = \frac{\text{Pounds per Day}}{[\text{Flow}(\text{MGD}) \times 8.34 \text{ lb/gal}]}$$

Pie Formula



Multiply across
bottom to solve
top of chart.

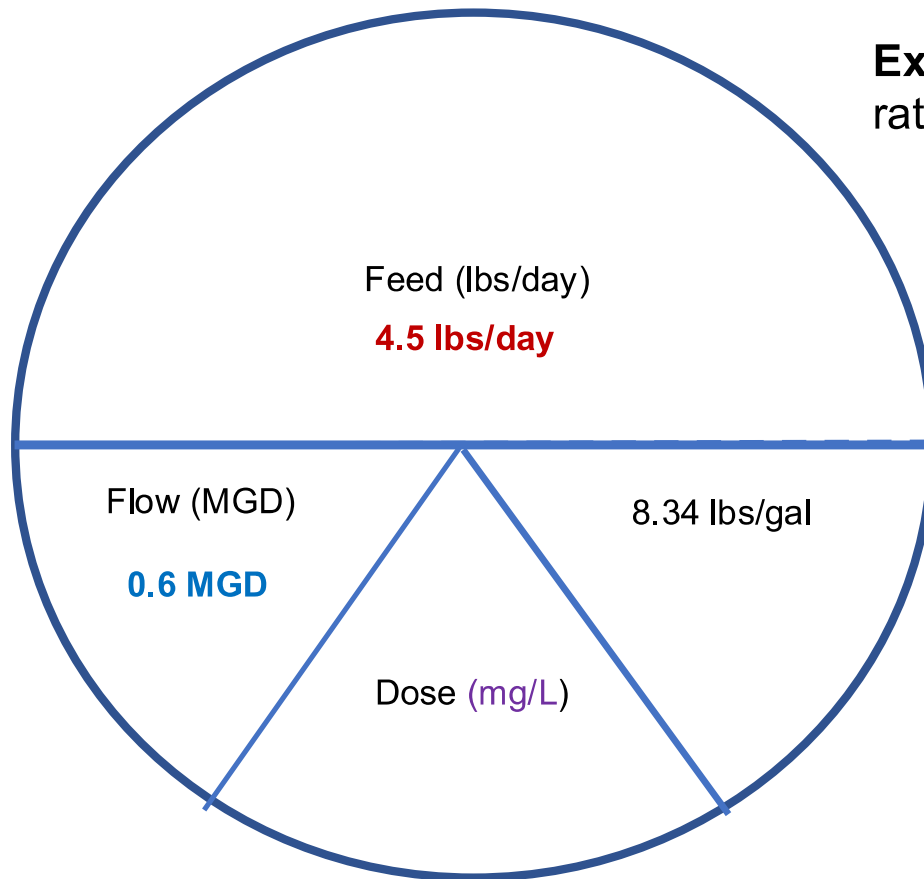
Example: Calculate the gas
chlorine feed rate for a plant
with a flow of **0.6 MGD** and a
dose of **0.9 mg/L**

$$\text{MGD} \times \text{mg/L} \times 8.34 \text{ lb/gal} = \text{lbs/day}$$

$$\mathbf{0.6 \text{ MGD}} \times \mathbf{0.9 \text{ mg/L}} \times 8.34 \text{ lb/gal} = \mathbf{4.5 \text{ lbs/day}}$$

Pie Formula (When solving for an unknown in the bottom.)

Example: Calculate the dose if gas chlorine feed rate is **4.5 lbs/day** and the plant flow is **0.6 MGD**.



$$\text{Dose} = \frac{\text{Feed in Pounds per day}}{\text{MGD} \times 8.34 \text{ lb/gal}}$$

$$\text{Dose} = \frac{4.5 \text{ pounds per day}}{0.6 \text{ MGD} \times 8.34 \text{ lbs/gal}}$$

$$\text{Dose} = 0.9 \text{ mg/L}$$

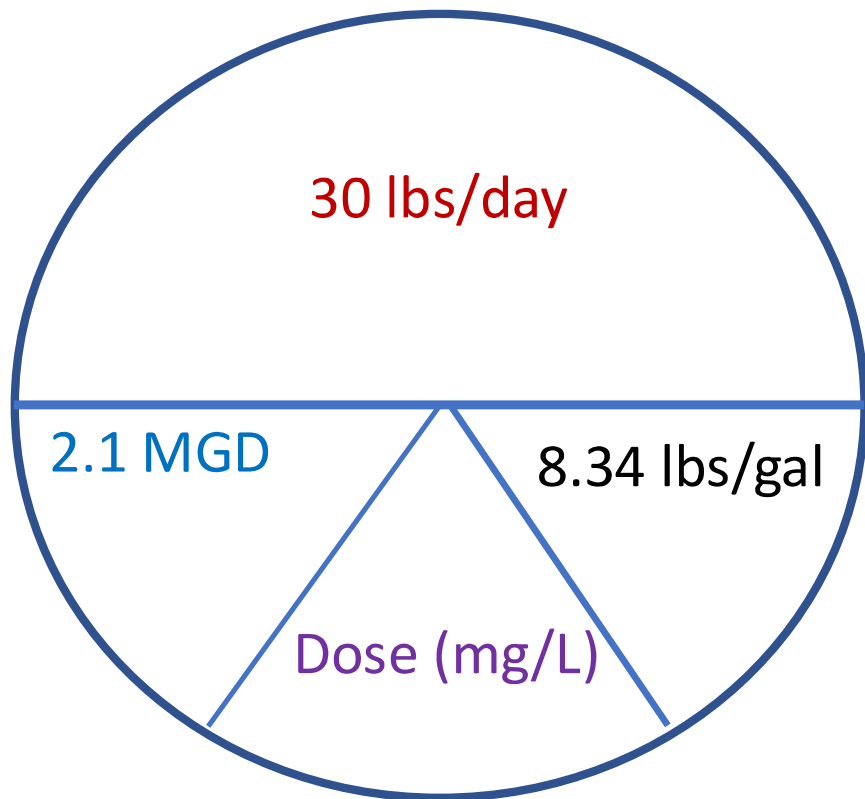
Poll 2

An operator checks the settings at a treatment plant and notes that the gas chlorine feed rate is set at 30 pounds per day and that the plant flow is 2.1 MGD. What is the dose of chlorine in mg/L that is being administered to this water source?

- a) 1.7 mg/L
- b) 0.58 mg/L
- c) 0.33 mg/L
- d) 0.15 mg/L



An operator checks the settings at a treatment plant and notes that the chlorine feed rate is set at **30 pounds per day** and that the plant flow is **2.1 MGD**. What is the **dose of chlorine in mg/L** that is being administered to this water source?



$$\text{Dose (mg/L)} = \frac{\text{Pounds per Day}}{[\text{Flow (MGD)} \times 8.34 \text{ lb/gal}]}$$

$$\begin{aligned} \text{Dose} &= \frac{30 \text{ Pounds per day feed}}{2.1 \text{ MGD} \times 8.34 \text{ lb/gal}} \\ &= 1.7 \text{ mg/L} \end{aligned}$$

Calcium Hypochlorite

(Also called high test hypochlorite or HTH).

$$\text{Lbs} = \frac{\text{Volume MG} \times \text{Dose in mg/L} \times 8.34 \text{ lbs./gal}}{\% \text{ strength of HTH}}$$

Top part of equation
calculates lbs of pure Cl

Dividing by % strength gives
weight of material needed.



Calcium hypochlorite can be in the form of tablets (often called pucks), pellets, or powder. It is generally 65% to 70% strength.

Disinfection with HTH

How many pounds of 65% strength HTH are required to disinfect 0.6 MG of water with a total residual of 1.5 mg/L?

Use the calcium hypochlorite formula

$$\begin{aligned}\text{Pounds HTH} &= \frac{0.6 \text{ MG} \times 1.5 \text{ mg/L} \times 8.34 \text{ lb/gal}}{0.65} \\ &= \frac{7.506 \text{ lbs}}{0.65} = 11.5 \text{ lbs}\end{aligned}$$

Note: The top part of the equation indicates that we would need 7.5 lbs. of 100% strength gas chlorine for the same level of disinfection.



Specific Gravity

The ratio of the weight of a substance to the weight of water is called specific gravity. Water weighs **8.34 lbs./gal** and has a specific gravity of 1.0.

Calculate the weight of 1 gallon of 12.5% sodium hypochlorite, assuming it has a specific gravity of **1.2**.

$$1.2 \times 8.34 \text{ lbs./gal} = 10 \text{ lbs./gal}$$



Calculating Feed Rates for Sodium Hypochlorite

$$\text{Gallons per day} = \frac{\text{MGD} \times \text{mg/L} \times 8.34 \text{ lbs./day}}{\% \text{strength} \times \text{weight per gallon}}$$

Top part of equation calculates lbs of pure Cl

Dividing by % strength gives weight of sodium hypochlorite liquid actually needed. Use the decimal equivalent of percent (i.e. 12.5% = 0.125)

Dividing by weight per gallon will give you the feed rate in gallons

$$\text{Gallons per day} = \frac{\text{MGD} \times \text{mg/L} \times 8.34 \text{ lbs/day}}{\% \text{strength} \times \text{s.g.} \times 8.34 \text{ lb/gal}}$$

Weight per gallon



What is the feed rate for 12.5% sodium hypochlorite with a s.g. of 1.2 when the plant flow is 0.5 MGD and the dosage is 0.9 mg/L?

Solution: Use the following formula, and plug in values for flow, dosage, specific gravity, and solution strength.

$$\text{Gallons per day} = \frac{\text{Flow (MGD)} \times \text{Conc. (mg/L)} \times 8.34 \text{ lbs/day}}{\% \text{strength} \times \text{s.g.} \times 8.34 \text{ lb/gal}}$$

$$\frac{0.5 \text{ MGD} \times 0.9 \text{ mg/L} \times 8.34 \text{ lb/gal}}{0.125 \times 1.2 \times 8.34 \text{ lb/gal}} = 3 \text{ gallons per day}$$



Chemical Pump Feed Information



Max Flow given as **0.58 GPH**
When speed and stroke are both set to 100%

Chemical Feed Pump Output

A chemical feed pump is rated for a maximum flow of 0.58 gallons per hour (gph). What is the actual output of the pump if both the stroke and speed are set at 70%.

Actual Output = Max Output x [%Stroke x % Speed]

We will use the decimal equivalent of 70% which is 0.7 for the stroke and speed.

Actual output = 0.58 gph x (0.7 speed x 0.7 stroke) = 0.284 gph

Notice that this setting produces about half the pump's maximum capacity which leaves flexibility for the operator to adjust the pump up or down.

Output in gallons per day → 0.284 gph x 24 hr/day = 6.82 gpd

This calculation can be compared to the sodium hypochlorite feed rate calculation.

Disinfection Contact Time

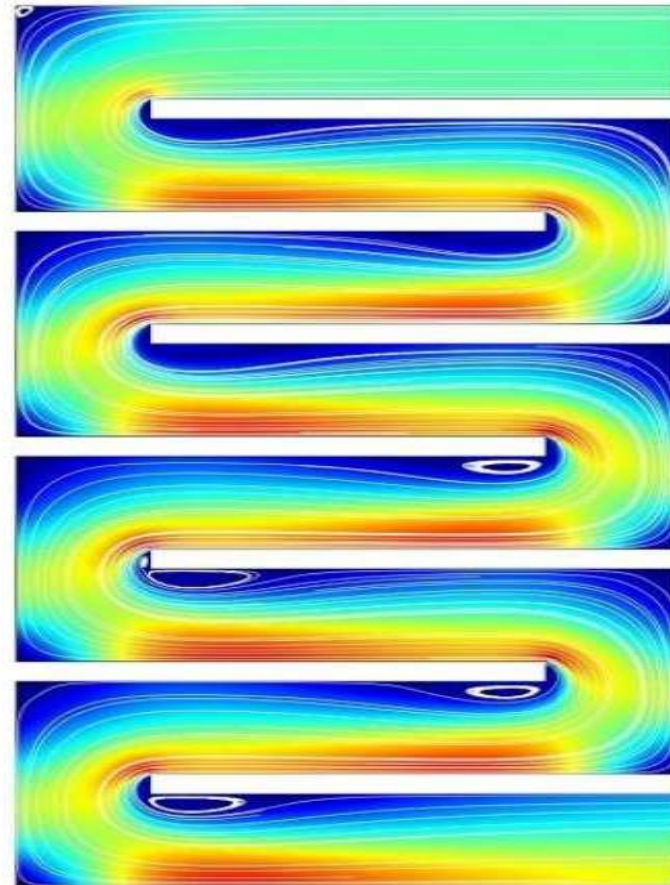
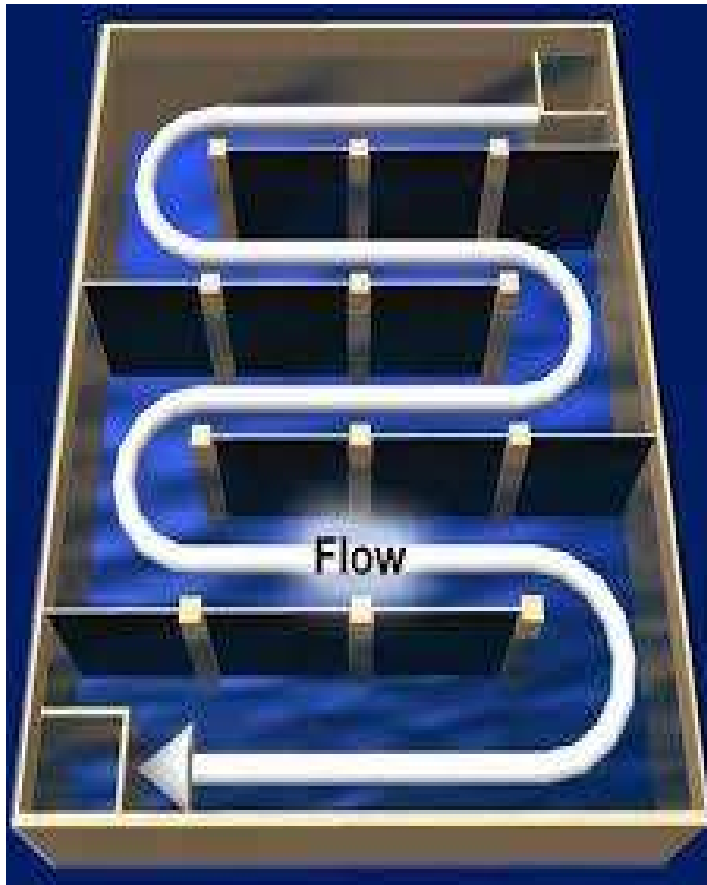
Theoretical Detention Time (assumes no short-circuiting).

$$\text{Time} = \frac{\text{Volume}}{\text{Flow}}$$

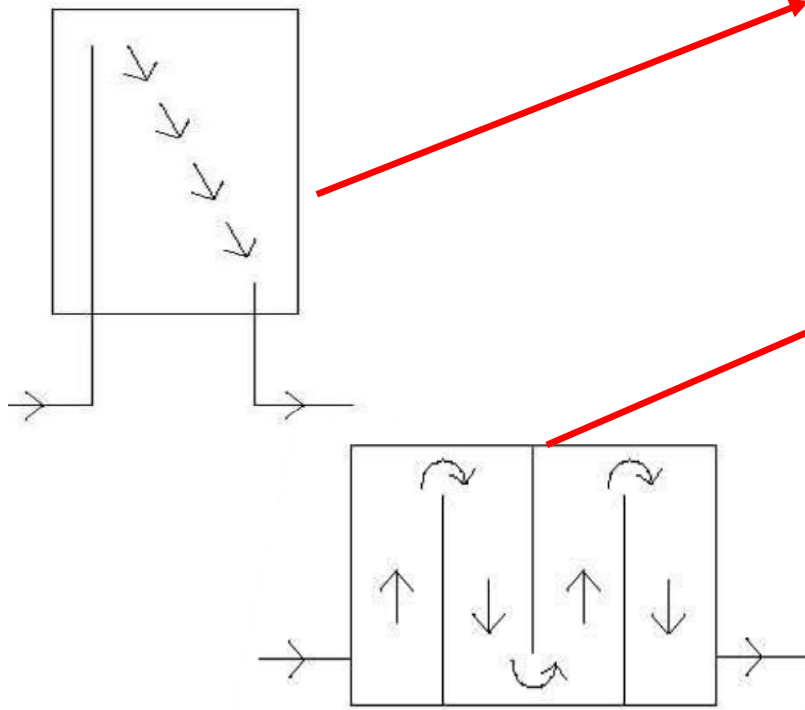
Disinfection Contact Time (Uses a baffling factor to account for short circuiting)

$$\text{Time} = \frac{\text{Volume (gallons)}}{\text{Flow (gallons per minute)}} \times \text{Baffling Factor}$$

Clearwell Design and Short Circuiting

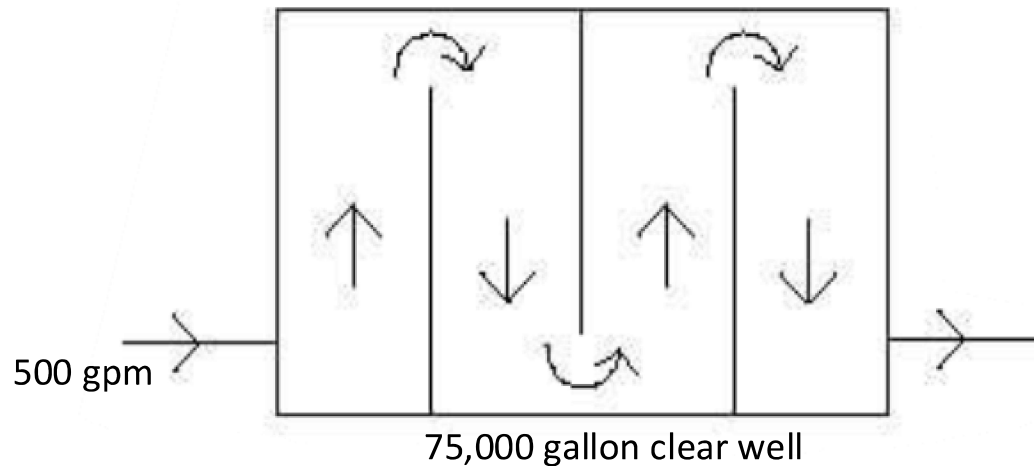


Baffling Factor indicates the degree of short circuiting.



Baffling Condition	Baffling Factor	Baffling Description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir or perforated launders.
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles.

What is the disinfection contact time for a tank that has a volume of **75,000 gallons** and a **baffling factor of 0.5**, if the flow through the tank is **500 gpm**?



Solution:

$$\text{Contact Time} = \frac{75,000 \text{ gallons} \times 0.5}{500 \text{ gpm}} = 75 \text{ minutes}$$



CT Values and Log Inactivation Requirements:

SWTR log treatment requirements for viruses and giardia

- 3-log inactivation + removal of Giardia (99.9%)
- 4-log inactivation + removal of viruses (99.99%)

(The combination of filtration and disinfection must achieve minimum 3 log removal/inactivation of Giardia lamblia cysts and 4 log removal/inactivation of viruses)

Considerations:

- Multiple barriers that are robust (source protection, filtration, testing, etc.)
- Disinfection byproduct formation (need to limit chlorination)
- Specific requirements of regulatory agency (state specific)
- Plant design (removal credits)

CT Table for 4-log Inactivation of Viruses with Chlorine

Temperature (°C)	Log Inactivation1	
	4.0	
	pH 6-9	pH 10
0.5	12	90
5	8	60
10	6	45
15	4	30
20	3	22
25	2	15

To use the table

Match the daily minimum temperature and daily maximum pH of your water source. Disinfection is more effective at higher temperatures.

Example: You measure pH and Temp

1. The temperature of your water is 16 degrees C (choose the lower option).
2. The pH of your water is 7.5 (choose the pH range).
3. The table indicates we need to attain a CT value of 4 or greater to order to satisfy 4-log inactivation of viruses.

Log 4 Virus Inactivation Problem:

A small ground water system maintains a minimum free chlorine residual of **0.8 mg/L**. Contact time is provided by a **3,500-gallon** pneumatic storage tank with a **B.F. of 0.3**. Maximum flow through the tank is **200 GPM**. Determine if the system is attaining sufficient CT for 4-log virus inactivation when the water **temp is 16 C** and water **pH is 7.5**.

Step 1: Determine contact time.

Time = $\frac{3,500 \text{ gallons}}{200 \text{ gpm}} \times 0.3 = 5.25 \text{ minutes}$

Step 2: Calculate CT being attained

$0.8 \text{ mg/L} \times 5.25 \text{ minutes} = 4.2 \text{ mg-min/L}$

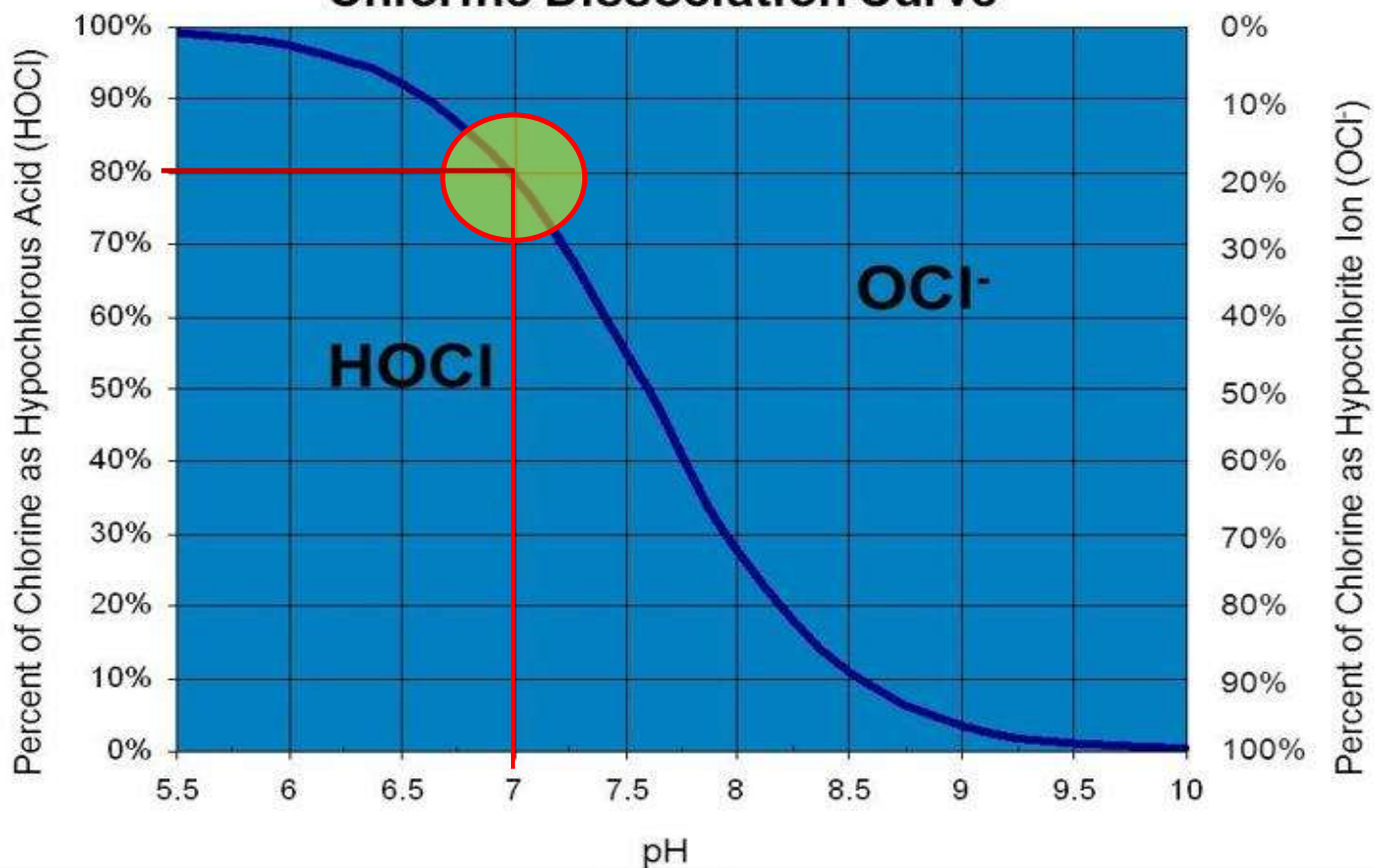
Step 3: Compare CT with required log 4 CT

Required CT for this pH and temp is 4.0. Actual CT is slightly greater; therefore, CT for log 4 virus is met.

Temperature (°C)	Log Inactivation1	
	4.0	
	pH 6-9	pH 10
0.5	12	90
5	8	60
10	6	45
15	4	30
20	3	22
25	2	15

The Effect of Water pH on Free Chlorine Residual

Chlorine Dissociation Curve



Notes:

Free chlorine residual consists of unreacted

- hypochlorous acid (HOCl) and
- hypochlorite ion (OCl⁻)

Hypochlorous acid is more effective because it has a greater ability to oxidize pathogens.

From the graph we see that at a pH of 7.0, free residual is

- 80% HOCl and
- 20% is OCl⁻

Giardia Inactivation Table

Table C-4. CT Values for Inactivation of Giardia Cysts by Free Chlorine at 15°C

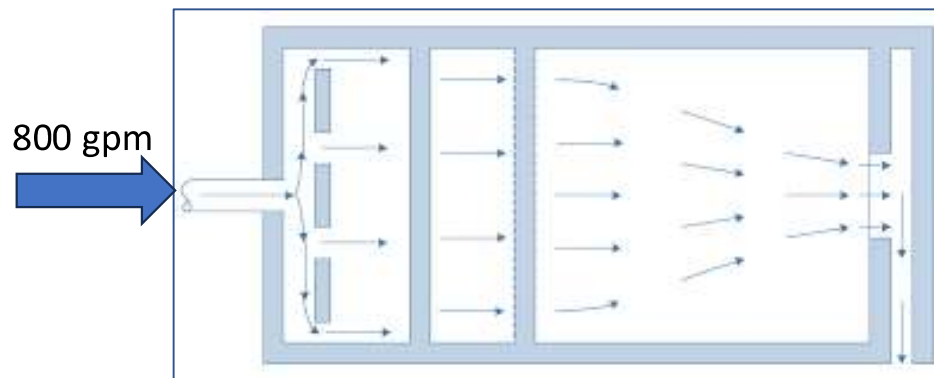
CHLORINE CONCENTRATION (mg/L)	pH≤6 Log Inactivation						pH=6.5 Log Inactivation						pH=7.0 Log Inactivation						pH=7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

1. Measure the **free chlorine** residual at the **END** of the disinfection process (entry point to DS).
2. Measure temperature and pH at the same location.
3. Choose the table that matches the temperature (use the next lowest temperature for temps in-between).

Log 3 Giardia Inactivation Problem:

A flow of 800 gpm water enters a 75,000-gallon clear well that has a baffling factor of 0.7. The water at the entry point to the distribution system is chlorinated to have a free residual of 1.2 mg/L.

Minimum water temperature is 15 C , maximum pH is 7.0, and the minimum free **chlorine residual is 1.2 mg/L**. Determine if the system has sufficient contact time and residual to achieve 3-log inactivation for Giardia.



75,000 gallon clear well
BF = 0.7

Contact time

$$\frac{75,000 \text{ gal} \times 0.7}{800 \text{ gpm}} = \mathbf{65.6 \text{ min}}$$

CT

$$1.2 \text{ mg/L} \times 65.6 \text{ min} = \mathbf{78.7 \text{ mg-min/L}}$$

Next: Compare to 15 C Giardia table

Step 4: Determine Required CT for 3-Log Inactivation

Find the required CT on the Giardia inactivation table using water temperature of 15 C , maximum pH of 7.0, and the minimum free chlorine residual of 1.2 mg/L.

Required CT = 76 mg-min/L

Our calculated CT of 78.7 mg-min/L exceeds the minimum required CT; therefore, compliance has been achieved!

Table C-4. CT Values for Inactivation of Giardia Cysts by Free Chlorine at 15°C

CHLORINE CONCENTRATION (mg/L)	pH≤6 Log Inactivation						pH=6.5 Log Inactivation						pH=7.0 Log Inactivation						pH=7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

Calculating Log Inactivation For Compliance

$$\text{Log inactivation (99.9)} = 3 \times \frac{\text{CT achieved}}{\text{CT required}}$$

$$\text{Log inactivation (99.9)} = 3 \times \frac{78.7 \text{ mg-min/L}}{76 \text{ mg-min/L}} = 3.1 \text{ Log}$$

If the surface water treatment plant were credited with **2.0 log removal** (due to a filtration process), the total Log treatment (inactivation + removal) would be:

3.1 log inactivation + **2.0 log** removal = **5.1** total Log treatment.

If inactivation log treatment is lower (i.e. 1.5 log instead of 3.0)

- Count removal credit from filtration (1.5 + 2.0 = 3.5)
- Increase residual and/or improve baffling (Increase CT)
- Add additional clear well volume (Increase contact time)
- Decrease pH of water (more effective disinfection)

Disinfection Byproduct Formation



Total Trihalomethanes (TTHM)

- Chloroform
- Bromodichloromethane
- Dibromochloromethane
- Bromoform

Trihalomethanes are volatile organic compounds that pose a cancer risk over the MCL of 0.080 mg/L for the Locational Running Annual Average (LRAA).

Haloacetic Acids (HAA5)

- Monochloroacetic acid
- Dichloroacetic acid
- Trichloroacetic acid
- Bromoacetic acid
- Dibromoacetic acid

HAA5 are weak acids that pose a cancer risk when over the MCL of 0.060 mg/L for the LRAA.

Both TTHM and HAA5 compounds are the result of reactions between chlorine and natural organic matter (NOM) – primarily the decay products of plant and animal materials (humic and fulvic acids).

Poll 3

A 30,000-gallon clear well with a BF of 0.7 has a flow of 500 gpm passing through it. A chlorine dosage of 2.0 mg/L is required to achieve a free residual of 1.7 mg/L at the entry point to the DS.

What CT value is being achieved in this clear well?

- a) 120.3 mg-min/L
- b) 102.1 mg-min/L
- c) 84.5 mg-min/L
- d) 71.4 mg-min/L

Poll 3 Solution

A 30,000-gallon clear well with a BF of 0.7 has a flow of 500 gpm passing through it. A chlorine dosage of 2.0 mg/L is required to achieve a free residual of 1.7 mg/L at the entry point to the DS.

What CT value is being achieved in this clear well?

$$\text{Time} = \frac{30,000 \text{ gal}}{500 \text{ gpm}} \times 0.7 = 42 \text{ minutes}$$

$$\text{CT} = 42 \text{ min} \times 1.7 \text{ mg/L} = 71.4 \text{ mg-min/L}$$

*Note: We need to use the free residual measured at the end of the disinfection process.
(Just after the clear well).*

Recommended Reference Materials

1. **The CT Method: A Reference Guide: North Carolina Area Wide Optimization Program Team. April 21, 2020.**
<https://deq.nc.gov/media/16645/download>
2. **Disinfection Profiling and Benchmarking - Technical Guidance Manual. EPA 815-R-20-003. USEPA, 2020.**
https://www.epa.gov/system/files/documents/2022-02/disprof_bench_3rules_final_508.pdf
3. **USEPA Guidance Manuals for the Surface Water Treatment Rules.** https://19january2017snapshot.epa.gov/dwreginfo/guidance-manuals-surface-water-treatment-rules_.html
4. **Pipe disinfection calculator:** https://moruralwater.org/water-tools-files/tool_pdfc.php
5. **Drinking Water Regulations.**
<https://www.epa.gov/dwreginfo/drinking-water-regulations>
6. **Surface Water Treatment Rules.**
<https://www.epa.gov/dwreginfo/surface-water-treatment-rules>

For more resources and contact

Environmental Finance Center Network

<https://efcnetwork.org/>

- Funding guides
- Request technical assistance
- Register for training events
- Tools, resources, videos, articles

Instructor contact,

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Thank you for participating

Please share one thing you enjoyed learning about today in the chat.

