



## WATER DISINFECTION

### Topics Covered

- Disinfectants
- Superchlorination and Hyperchlorination
  - Safe Handling of Disinfectants

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### Disinfectant Product Types

Type	Appearance	Effect on pH	Active disinfectant produced	Stabilized?
Sodium hypochlorite	Liquid	Up	Hypochlorous acid	No
Calcium hypochlorite	Powder, Tablets	Up	Hypochlorous acid	No
Lithium hypochlorite	Powder	Up	Hypochlorous acid	No
Trichlor	Tablets, Powder	Down	Hypochlorous acid	Yes
Dichlor	Powder	Neutral	Hypochlorous acid	Yes
Bromine	Powder, Tablets	Down	Hypobromous acid	No
Chlorine gas	Gas	Down	Hypochlorous acid	No

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## Disinfectant Types

- Chlorine based products:
  - Some are stabilized, some are not
  - "Stabilized" means it contains Cyanuric Acid
  - Chlorine chemistry well understood
- Bromine based products:
  - None are stabilized
  - Bromine chemistry not well understood

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## Basic Chlorine Chemistry

- Chlorine is an oxidizing agent (burns things like oxygen does)
- Oxidizing agents steal electrons from other chemicals
- Chemicals willing to give electrons to oxidizing agents are called reducing agents
- Oxidation-Reduction Potential (ORP) close to but not the same as concentration of disinfectant
- Automatic chemical feeder with ORP meter for maintenance of chemical levels (not for initial setting)

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## Basic Chlorine Chemistry

- Chlorine + Water = Hypochlorous acid + Hypochlorite ion
- Hypochlorous acid: Active disinfectant
- Hypochlorite ion: non-active disinfectant
- Hypochlorous acid and Hypochlorite ion change into each other depending on pH
  - Low pH: More Hypochlorous acid
  - High pH: More Hypochlorite ion
- Hypochlorous acid and Hypochlorite ion are both strong oxidizing agents

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## Basic Chlorine Chemistry

- Hypochlorous acid + Hypochlorite ion = Free Chlorine
- Free chlorine test is measuring both Hypochlorous acid + Hypochlorite ion combined
- Free chlorine + other chemicals = Combined Chlorine
  - Other chemicals are urine, sweat, lotion, deodorant, sunscreen, etc.
- Free chlorine + Combined Chlorine = Total Chlorine

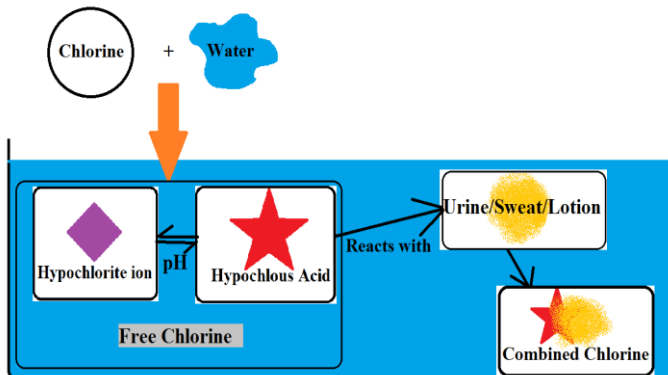
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## Basic Chlorine Chemistry

- Combined chlorine is an ineffective disinfectant
- Combined chlorine smells like chlorine and is irritating
- Combined chlorine may cause asthma and other severe illnesses
- Drain or "shock" the pool to get rid of combined chlorine

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## Summary in Picture



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## Disinfectant Requirements

246-260-999  
Appendix A — Water quality standards.

Table 111.1  
Minimum and Maximum Levels of Disinfectant (ppm)\*

SWIMMING POOL: ***	Minimum
Chlorine	1.5
Chlorine with cyanurate compound	2.0
Bromine	2.5
SPA & WADING POOL: ***	Minimum
Chlorine	3.0
Chlorine with cyanurate compound	3.5
Bromine	4.0

\* Chlorine is measured as free available chlorine residual.

\*\* Recirculating spray pools and sensory deprivation tanks shall meet spa and wading pool levels.

\*\*\* The maximum disinfectant level shall conform with manufacturers' recommendations and shall not exceed 10 ppm for any pool.

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## What is ppm?

### Parts per million

- Parts per million is used to measure a small amount of something in a big amount of something else.
- Also known as mg/L (milligrams per liter)
- Example
  - A teaspoonful of salt: 5 grams (5,000 mg)
  - A typical bathtub: 80 gallons (300 liters)
  - $5,000/300=16.7$  ppm
- Maintaining it in the proper range can be tricky.

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## How to Dose Disinfectants

### Example:

- You have 1.0 ppm of Free Chlorine in your pool
- You want to raise it to 3.0 ppm
- Your pool is 25,000 gallons
- You use calcium hypochlorite

How much calcium hypochlorite do you need to add?

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## How to Dose Disinfectants

Disinfectant Type	Add this much to increase by 1.0 ppm
Calcium Hypochlorite	2 oz
Sodium Hypochlorite	10.7 fl.oz. (1 fl.oz.=0.125 cups)
Trichlor	1.5 oz (This adds 0.6 ppm of cyanuric acid to the pool as well)

These numbers are for every 10,000 gallons of pool water.  
Adjust according to the volume of your pool.  
Always follow the manufacturer's instruction.

## How to Dose Disinfectants

You need 2 oz of calcium hypochlorite to raise free chlorine by 1.0 ppm in 10,000 gallons of water

- 1.0 ppm  $\Rightarrow$  3.0 ppm: Raising it by 2.0 ppm: 2 times as much as 1.0 ppm
- Your pool is 25,000 gallons: 2.5 times bigger than 10,000gallons
- Required amount of calcium hypochlorite is:
- $2 \text{ oz} \times 2 \times 2.5 = \text{Answer } 10 \text{ oz.}$

## Superchlorination vs Hyperchlorination

### Superchlorination

- Also known as "shocking" or "breakpoint chlorination"
- Superchlorinate: when too much combined chlorine is in the pool (Combined Chlorine > 50% of Free Chlorine)
- Raise the level of free chlorine to 10 times the level of combined chlorine
- This will drive the combined chlorine out of the pool and into the air above it

## Superchlorination vs Hyperchlorination

- You have 2.0 ppm of Free Chlorine
- You have 2.0 ppm of Combined Chlorine
- You are using Sodium Hypochlorite
- Your pool is 5,000 gallons

How much sodium hypochlorite do you need to shock this pool?

Disinfectant Type	Add this much to increase by 1.0 ppm
Sodium Hypochlorite	10.7 fl.oz.

These numbers are for every 10,000 gallons of pool water.  
Adjust according to the volume of your pool.  
Always follow the manufacturer's instruction.

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## Superchlorination vs Hyperchlorination

### Hint:

- You need to raise the free chlorine level by 18 ppm
- Your pool is only 5,000 gallons, which is a half of 10,000 gallons

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## Superchlorination vs Hyperchlorination

**Answer:** 10.7 fl.oz. X 18 X ½ = 96.3 fl.oz.

Things to remember:

- Do not add stabilized chlorine to shock
- If indoor, open up the windows and doors.
  - Combined chlorine is corrosive and unhealthy
  - Combined chlorine in the air will be absorbed back into the pool
- Wait until chlorine level comes down to acceptable range before opening
- Potassium monopersulfate (oxidizing agent) to get the same result. Interferes with Combined Chlorine test.

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## Superchlorination vs Hyperchlorination

### Hyperchlorination

- Hyperchlorinate after a diarrhea incident
- Follow the CDC guidelines for specific <https://www.cdc.gov/healthywater/swimming/pdf/fecal-incident-response-guidelines.pdf>

## Safe Handling of Disinfectants

- Remember disinfectants are strong oxidizers
- Do not mix disinfectants with other disinfectants, chemicals, or materials
- Examples of deadly combinations:
  - Calcium hypochlorite + Trichlor = Fire/Explosion
  - Calcium hypochlorite + debris = Fire/Explosion
  - Any chlorine disinfectant + acid = Chlorine gas
- Mixing chemicals with water produces heat
  - Mix small amount of chemical into large amount of water
  - Doing it the other way would cause violent reaction with heat and fumes

## Questions?

