

Managing pH for the Maximum Antimicrobial Effectiveness of Chlorine in Processing Water

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Many, if not most, poultry slaughter operations use some form of chlorine in water for the reduction of pathogens, e.g. in chillers for the reduction of *Salmonella spp.*

Common sources of chlorine are:

Sodium hypochlorite (NaOCl – bleach)

Calcium hypochlorite [Ca(OCl)_2 swimming pool granules]

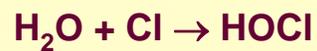
Chlorine gas (Cl_2)



The Chemistry of Chlorine – A Quick Review



To accomplish disinfection and oxidation, a chemical reaction between chlorine and water (hydrolysis) must occur to form hypochlorous acid (HOCl).



HOCl is the chemical agent that destroys bacteria.

HOCl kills microbes by oxidation – removing electrons from their cell membrane



Mixing chlorine and water does not necessarily produce an abundance of HOCl.

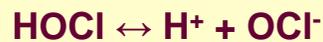
HOCl is a “weak” acid - it tends to undergo partial dissociation as follows:



Only HOCl is antibacterial; the hypochlorite ion (OCl⁻) isn't.



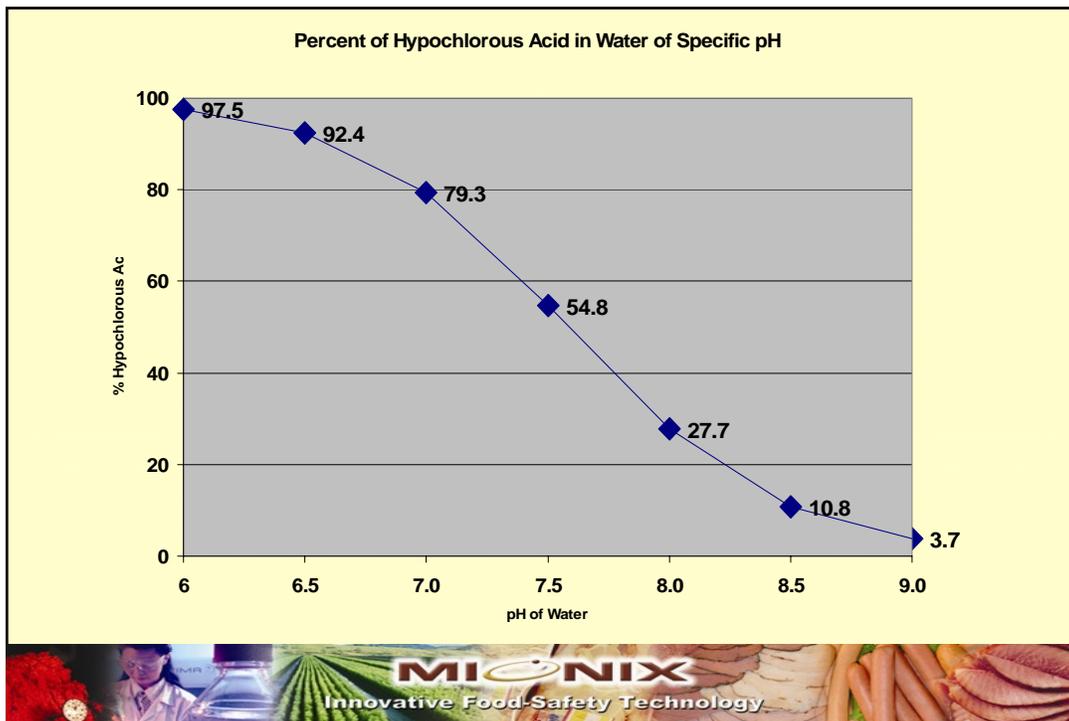
Why is pH Control Important?



pH determines the direction of this equilibrium.

The lower the pH, the more HOCl; the higher the pH, the more H⁺ + OCl⁻





The key to effective chlorine use is to keep it in the form of “HOCl.”

This is accomplished by controlling the pH of the water.



Water Quality

Source

- Well
- Surface

- pH
- Alkalinity
- Hardness



Terminology

Total Chlorine = bound + free available

Free available = HOCl + OCl⁻

Oxidation Reduction Potential (ORP)

Measures the antimicrobial capability in the water.

Is an indicator of the level of HOCl rather than a direct measurement.



Measuring the antimicrobial potential in water ORP (Oxidation Reduction Potential)

- Measured in millivolts (mV)
- 650-700mV recommended¹
- Value is a range, not a fixed number

Not a practical method for monitoring the antimicrobial potential of water treated with hydrogen peroxide or peroxyacetic acid.



ORP (Cont.)

USDA/ARS cautions against the use of citric acid –¹

- May interfere with the lethal action of HOCl.
- Recommends the use of a food-grade inorganic acid.



Summary of Results from Various Lab Simulation and Commercial Hydrocooler Survey Studies¹

Pathogen/Indicator	Survival at ORP (mV)		
	< 485	550 < x < 620	> 665
<i>E. coli</i> O157:H7	> 300 s	< 60 s	< 10 s
<i>Salmonella</i> spp.	> 300 s	> 300 s	< 20 s
<i>L. monocytogenes</i>	> 300 s	> 300 s	< 20 s
Thermotolerant coliform	> 48h	> 48h	< 30 s



Forms of Acidifiers

1. Dry powders

Advantages

- a. less freight

Disadvantages

- a. Must be mixed:
 - increased labor
 - higher risk of mixing errors
 - inconsistent results
- b. Potential safety hazard to workers during mixing.
- c. Undissolved solids can plug hoses and nozzles.



Forms of Acidifiers (Cont.)

2. Gas – CO₂

Advantages

- a. No mixing required
- b. Relatively inexpensive

Disadvantages

- a. Need to monitor the CO₂ in the air
- b. Difficult to automate
- c. Need an automatic cut off to stop the flow of gas in case of a power outage



Forms of Acidifiers (Cont.)

3. Ready-to-use liquids

Advantages

- a. No mixing required:
 - less labor
 - less mixing errors
 - consistent results
 - easily automated
- b. Reduces safety hazard to workers
- c. No undissolved solids to plug hoses and nozzles

Disadvantages:

- a. Freight – purchase in bulk



Automate Your System



Possible Locations of Use

- Pre-Slaughter Wash
- Scalders
- Pickers
- NY Wash
- Chillers
- Carcass Wash
- Sprayers on line (Pre and Post Chill)
- Sprayers on Equipment
- Anywhere the water is chlorinated



Avoid Misuse

- Use as directed
- Use as written in food safety documents

Educate the User

- Train the user
- Document the training



Reference

1. Suslow, Trevor V., Oxidation-Reduction Potential (ORP) for Water Disinfection Monitoring, Control, and Documentation, Publication 8149 University of California, Division of Agriculture and Natural Resources

Additional information on using ORP – <http://anrcatalog.ucdavis.edu>

