Optimize Water Quality

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Optimizing Water Quality
Best return on investment

What Counts!

- Bacteria
- pH
- Minerals
- Sanitation
  - During the flock
  - Between flocks
- Monitoring

Pathogens in Water

- Disease causing organisms:
  - bacteria- from human and animal feces
  - viruses- shed by infected animals
  - protozoan- Giardia best known
- Total coliform used as indicator
  - Originate in intestinal tract
  - Presence indicates waste or surface contamination
  - Persists in water

Bacteria

- Focus on total bacteria counts-CFU/ml
- Indicator of the biofilm status
- Biofilms are a leading source of health issues
- Poor line sanitation _______ biofilm
- Salmonella can live for weeks in a biofilm
- Grows when we add:
  - Vitamins
  - Electrolytes
  - Milk replacers, etc.
- Once established biofilms are 10-1000 times more resistant to cleaning

BioFilms

Microorganisms within the pollution are protected from antibacterial agents.
Aerobic Bacteria Levels in Water From Poultry Farms

<table>
<thead>
<tr>
<th>Farm</th>
<th>CFU/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-- At source</td>
<td>2,700</td>
</tr>
<tr>
<td>A-- At end of line</td>
<td>26,600</td>
</tr>
<tr>
<td>B-- At source (community)</td>
<td>203,000</td>
</tr>
<tr>
<td>B-- At end of line</td>
<td>2,340,000</td>
</tr>
<tr>
<td>C-- At source (community)</td>
<td>600</td>
</tr>
<tr>
<td>C-- At end of line</td>
<td>282,000</td>
</tr>
<tr>
<td>D-- At source</td>
<td>0</td>
</tr>
<tr>
<td>D-- At end of line</td>
<td>4,775,000</td>
</tr>
</tbody>
</table>

Acceptable Bacteria Levels in Water

<table>
<thead>
<tr>
<th></th>
<th>Level con. Average</th>
<th>Maximum acceptable</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Bacteria</td>
<td>0/ml</td>
<td>100/ml</td>
<td>0/ml desirable and do-able</td>
</tr>
<tr>
<td>Coliform</td>
<td>0/ml</td>
<td>50/ml</td>
<td>0/ml</td>
</tr>
</tbody>
</table>

When to Test for Bacteria

- Noticeable change in color, odor or taste
- Flooding has occurred near well
- Person or animal becomes sick from waterborne disease
- Maintenance on water supply system
- Persistent poor performance
- Loss of pressure in water system

Effect of pH on Water Quality

- Measures how acidic or basic
- Change of one indicates ten fold change
- Less than 6.5, corrosive water
- pH < 5.9, poor performance ????
- pH > 8.0
  - Impacts chlorine activity
- Chlorine most effective in pH 4.0 - 6.5
How pH Affects Chlorine Ratio of Hypochlorous Acid to Chloric Ion

What Form is Your Chlorine?

- Hypochlorus acid is 80-300 times more effective as a sanitizer than chloric ion
- Free chlorine not considered effective unless it is 85 % Hypochlorus acid

Hypochlorus Acid

- Hypochlorus acid is 80 times more effective as a sanitizer than chloric ion
- Free chlorine not considered effective unless it is 85 % Hypochlorus acid
- Forget the chemistry lesson:

  • **pH range of 4 to 6.5 is best when using chlorine sanitizers**

NEVER!!
Mix bleach and acids in the same container

Chemtech Dual Injection Pumps

Must be in line with well not after pressure tank
Impact of pH on 42-Day Male Broiler Weights

Impact of pH on 42-Day Male Broiler Feed Conversion

Effect of Drinking Water pH on Broiler Digestive Tract

Effect of pH on Bacterial Growth

My Birds Flush When I Use an Acidifier

- Acidifiers are not sanitizers
- Most acidifiers need lots of contact time to damage or kill bacteria
- During high water usage, contact time is minimal
- Some bacteria may be resistant even thrive on it
- One size fits all directions for acidifiers may result in poor pH adjustment for high pH water
Water Acidification May Not Be Enough

<table>
<thead>
<tr>
<th>Product</th>
<th>pH</th>
<th>APC Count CFU/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8</td>
<td>8.2 mil</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>7</td>
<td>5.6 mil</td>
</tr>
<tr>
<td>CA</td>
<td>6</td>
<td>4.4 mil</td>
</tr>
<tr>
<td>CA</td>
<td>5</td>
<td>4.0 mil</td>
</tr>
<tr>
<td>CA</td>
<td>4</td>
<td>2.3 mil</td>
</tr>
</tbody>
</table>

5 minute exposure

Dry products mix better in warm or room temperature water

Mineral Content of Water

- Iron-red water
- Manganese- black solids
- Small quantity- bitter metallic taste for people
  - .3 ppm Fe-Iron
  - .05 ppm Mn-Manganese
- Both promote the growth of crenoform organisms
  - Form heavy gelatinous stringy masses that slough off
  - Reduces pipe volume
- Iron promotes *Pseudomonas* and *E. coli*

Minerals can impact drinkers
Filtration Options

- Sand filter
  - Good for oxidized minerals, some turbidity
  - Back flush necessary
    - Automatic back flush
    - Pressure back flush
  - Not adequate to remove bacteria, viruses, etc.
  - >$2,000 for 100,000 bird capacity

- Carbon filters
  - Removes Chlorine - that can be good or bad
  - Sulfur < 20 ppm
  - Hydrocarbons
  - Pesticides and PCBs
  - Volatile organic chemicals - benzene

Parker Hannifin Filtration Products

- Farm Guard Series
  - 10 to 120 GPM
  - Pleated filter
  - Capacity of 180 string filters
  - Can be washed, reused
  - Casing will not dent, rust, chip or corrode
  - Still need contact time (>20 minutes, pH 7-7.5) to precipitate iron

Progress Report on FarmGuard

- The FarmGuard filter was then washed by Dr. Brian Fairchild.
- Due to the low pressure drop, contaminant has not been forced deep into the pleats, allowing for future dirt holding.

Second Option for Iron

- Refers to the amount and types of chemicals that can shift pH > 7
- Usually expressed as calcium carbonate (CaCO₃)
- Also dependent on bicarbonate (HCO₃⁻)
- Poisons in nature usually alkaloid so high alkaline, content may back birds off water

Alkalinity

- Due to the low pressure drop, contaminant has not been forced deep into the pleats, allowing for future dirt holding.
- They showed no signs of contaminant reaching them.
What to do about Hardness

- Acidify drinking water
  - helps keep Ca in solution
  - Masks alkalinity taste concerns
- Klear Flo- Sequestering agent
  - Keeps Ca in solution
- Phosphate products also prevent scaling
- Water softener
  - Exchanges sodium for calcium

Alkaline Hydrolysis

- pH of >7.5 can impact insecticides
- pH range of 4 to 6 best for most insecticides
- Carbaryl (Sevin)
  - pH   Half-life
    - 6   100-150 days
    - 7   24-30 days
    - 8   2-3 days
    - 9   1 day
- To lower pH add citric acid or PWT to spray water

Nitrate

- Nitrate (NO₃⁻) can occur in groundwater
- Nitrate is colorless and odorless
- Water test only way to determine if present
- High levels indicate potential contamination by sewage, livestock or fertilizers
- High nitrates warning to test for bacteria
- More than 10 ppm linked to poor performance in broilers
- High nitrates and coliform bacteria linked to poor breeder performance
Water Sanitation

- Chlorine great sanitizer but no miracle worker
- Affected by:
  - pH, best pH 4.0 to 7.0
  - Concentration too low bacteria will live
  - Water temperature, < 65 loses effectiveness
  - Turbidity
  - Exposure time, too short will not work
  - Growth stage and type of bacteria present
  - Age and storage conditions of bleach

-Bottom Line:
Using bleach doesn’t always mean water is effectively sanitized

Recommended Chlorine Contact Time for Disinfection of Water at 40 to 50 °F

<table>
<thead>
<tr>
<th>Free Chlorine Residual (ppm)</th>
<th>Contact Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>1.0</td>
<td>8</td>
</tr>
<tr>
<td>2.0</td>
<td>4</td>
</tr>
<tr>
<td>4.0</td>
<td>2</td>
</tr>
<tr>
<td>8.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Chlorine Options

<table>
<thead>
<tr>
<th></th>
<th>Gas</th>
<th>CaHypo</th>
<th>NaHypo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine Content</td>
<td>100%</td>
<td>65%</td>
<td>11.9%</td>
</tr>
<tr>
<td>Aging</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect on pH</td>
<td>Lowers</td>
<td>Raises</td>
<td>Raises</td>
</tr>
<tr>
<td>Cost</td>
<td>Base</td>
<td>3-7 x</td>
<td>3-5 x</td>
</tr>
<tr>
<td>Safety Factor</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>
Monitoring Water Sanitation
Oxidation-Reduction Potential

- Measures the energy in water
- Free chlorine present- oxidizing energy will be high (> 600)
- Water dirty or no free chlorine, energy is low
  - Can even be a negative number
- Optimum ORP level- 650 to 750
  - Free chlorine levels of .2 to .4 ppm adequate

Careful with the bleach!
**Chlorine Dioxide Characteristics**

- Effective on bacteria, fungi, (virus)
- Good effectiveness on biofilm penetration
- Good stability in water
- Low gas off in soluble form, not stock
- Less corrosive than chlorine
- No chlorinated Disinfection-By-Products
- Inactivated/decomposes in sunlight
- Can be expensive to use and monitor

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**My birds have a slight snick . .**

- I want to run organic iodine as an expectorant, should I stop chlorinating?

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**My birds have a slight snick . .**

- I want to run organic iodine, should I stop chlorinating?
- Chlorine and iodine work well together
  - If chlorinating use second pump to inject iodine
  - May not get a chlorine reading when running both

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**pH, ORP, Total and Free CL**

<table>
<thead>
<tr>
<th>pH</th>
<th>ORP</th>
<th>T Cl</th>
<th>Free Cl</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.86</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1,250,000</td>
</tr>
<tr>
<td>6.47</td>
<td>425</td>
<td>5</td>
<td>2.5</td>
<td>&gt;10</td>
</tr>
<tr>
<td>5.85</td>
<td>540</td>
<td>5</td>
<td>2.5</td>
<td>&gt;10</td>
</tr>
<tr>
<td>5.17</td>
<td>615</td>
<td>5</td>
<td>2.5</td>
<td>&gt;10</td>
</tr>
<tr>
<td>3.91</td>
<td>705</td>
<td>5</td>
<td>2.5</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

Bleach 8 oz/gallon stock then 1:128
PWT used to adjust pH
What mixes?

- Basic products- Add ammonia
  - Sulfa drugs
  - Penicillin
- Acidic products- Add citric acid
  - Tetracycline
  - Erythromycin

Water Line Cleaning Trial

- Pullet farm which did not use daily sanitizer
- Birds had just been moved
- Water pH-8.6
- Evaluated:
  - Proxyclean at rates of 1% and 3%
  - 50% stabilized hydrogen peroxide
  - Anthium Dioxide + Acidic Barn Cleaner
  - (5% chlorine dioxide plus urea sulfate)
  - PWT-line cleaning rate 1 pack/2.5 gallons water
- Charged one line per product with sump pump

Condition of water (Pretreatment)

ProxyClean 1% - 20 Hours Post Treatment

ProxyClean 3%

- #1 - Dirty water from line
- #2 - Water from line after flush completed
Anthium Dioxide + Acidic Barn Cleaner

- #1 - Dirty water from Line
- #2 - Water from line after cleaning

PWT Treatment – pH was only 6.8 at time of collection

Line Cleaning Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Flush Water</th>
<th>After Flushed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proxyclean 3%</td>
<td>250</td>
<td>88,000</td>
</tr>
<tr>
<td>Proxyclean 1%</td>
<td>300</td>
<td>300,000</td>
</tr>
<tr>
<td>Anthium Dioxide</td>
<td>0</td>
<td>37,000</td>
</tr>
<tr>
<td>PWT</td>
<td>50,000</td>
<td>700</td>
</tr>
</tbody>
</table>

Control - 29,000 CFU/ml

Line Cleaning Theory

- Strong cleaners may agitate/disrupt biofilm
- Important to maintain sanitizing pressure to prevent re-establishment of displaced biofilm
- Rinsing with non-sanitized water probably why drinkers may “stick” after cleaning – Biofilm re-establishing in drinkers

Source of Clostridium??
Water Line Flush and ORP

- Well room with gas chlorinator - 745 ORP
- End of Water Line - pre flush - 365 ORP
- Flushed till water was cold - 750 ORP

Flush Water Lines

- Like washing a car
  - First rinse off the loose dirt
  - Allows cleaners access to the tough biofilm
- High pressure flush is most effective
- Any flush is helpful
  - Can remove sediment from lines
- At least once a week
- More if you have the time and water

Food for Thought

- Birds eat fast
- Crop simply a holding tank
- Feed easily digested for bird and bacteria
  - Corn already ground
  - Feed conditioned and cooked
  - Full of fat, sugars, etc.
- Add poor quality water to a crop full of feed
- May create conditions bird can’t overcome

Conclusion

- Poor water can impact birds and cost you money
- Good water quality rarely a given, it takes effort
- Know Your Water
  - Bacteria/biofilms present, may need extra cleaning
  - Mineral content, may need to filter
- Optimize sanitation
  - Sanitizers with residual give best results
  - If using chlorine, adjust pH
- Get the system clean between flocks, the only way we can have true success

Trial 3: Field Evaluation of Drinker Height on Broiler Weights

- Cumberland

- Spark Nipple

4.4
4.45
4.5
4.55
4.6
4.65
4.7
4.75

Cumberland
Spark Nipple

Lb
Trial 3. Field Evaluation of Drinker Height on Broiler Feed Conversion

Trial 3. Field Evaluation of Drinker Height on Broiler Mortality (%)