How to Prevent a Catastrophic Event

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How to Prevent a Catastrophic Event to Your Water or Wastewater System

WWW 5660
7 contact hours
9 CC10 hours

Operators and superintendents must recognize many of the common Standard Practices used at water and wastewater systems today can lead to a potential catastrophic issue at their facilities. This course looks at some of these issues, where if not addressed, can ultimately lead to events that potentially cause bodily harm or even kill operators and customers if not effectively addressed. First, we will look at the results of lack of verification of even the very basic chemicals delivered to our facilities, document case histories where events have occurred, and show system personnel how simple and easy a verification program is to establish. Next, we will address operational issues such as the laboratory result where the Pink-Red color that develops in the DPD Chlorine test, but is not chlorine; and what operations personnel can to do to mitigate these issues. Additionally, learn why the Infrastructure Age requires extra vigilance to prevent system contamination. Even with backflow prevention, the fact remains that a garden hose is still the number one potential contamination source for water systems. We will discuss why water stagnation and biofilm formation can lead to bacterial contamination and how operations can minimize these issues with simple low-cost steps.

1) Recognize how to complete a chemical verification process.
2) Explain how to minimize DPD chlorine interferences.
3) Examine why and how increased surveillance is a must with today's Aged Infrastructure.
4) Identify strategies related to controlling water stagnation and biofilms.

I) Introduction to course objectives (30 Minutes)
   a) Chemical delivery verification
   b) DPD issues
   c) Water stagnation
   d) Infrastructure age
   e) Biofilms

II) Hazards related to chemical delivery (120 Minutes)
   a) What all the paperwork doesn't tell you
   b) Why it's so important to have a verification program
   c) Elements of a good verification program
   d) The tools needed
   e) Selections process
   f) Case histories from systems where event occurred

III) Recognizing DPD Chlorine Interferences (60 Minutes)
   a) How to recognize
   b) Manganese
   c) Phosphorous
   d) Ammonia
   e) Not so common interferences
   f) Dealing with & and compensating for

IV) The System Age Factor….Infrastructure Age (60 Minutes)
   a) Identification
   b) Suggestions for better inspections
   c) Frequency
   d) Case histories related to system age

(V) Watch out for common backflow issues (30 Minutes)

a) The hose and just how easy it is to contaminate a public water system

b) Awareness

c) Systematic

(VI) Stagnation and Biofilm issues (120 Minutes)

a) Water age

b) Loss of chlorine

c) Keeping the water moving

d) Strategies

e) Bacteriological regrowth issues

f) Legionella

g) Case histories in MD

How To Prevent a Catastrophic Event At Your Water/Wastewater System

Steps Operator's Can Take To Prevent A Catastrophe At Your Water/Wastewater System

1

Original Title:

How to Invite A Catastrophe To Occur At Your Water Facility!!!!!

2

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Webster's Definition of A Catastrophic Event

* A sudden and widespread disaster: (the catastrophe of war).
* Any misfortune, mishap, or failure, A fiasco.
* An event causing great and often sudden damage or suffering; a disaster.
* In Short- Catastrophe's can KILL people!!!
* .

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What's At Issue Here?

* Failure to verify most every chemical delivered.
* Failure to always use the weakest practical strength of chemical.
* Failure to increase system surveillance because of infrastructure age.

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What's At Issue Here?

* Failure to recognize what water stagnation, & excess biofilms in the distribution can lead too
* Failure to recognize DPD Chlorine measurements, issues, and interferences.
* Failure to recognize even the simplest backflow condition (a hose) can lead to bacteria issues.

6

The DPD Colorimetric Chlorine Test…..Watch for Interferences & Variability, Applicable to both Water and Wastewater

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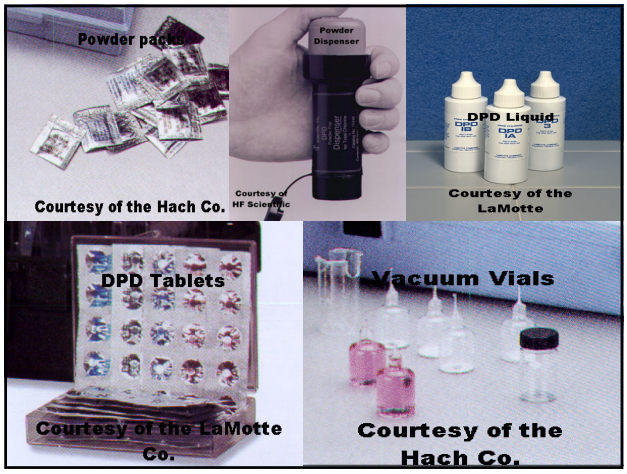

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DPD – Things To Watch For!

- DPD reagent systems……never stops reacting….continuous pink/red to purple/black
- Know the difference between "Free" and "Total" DPD reagent packs
- Use the correct sample volume with correct DPD Reagent packs
- Watch for DPD Reagent bleaching out
- Watch for "strange" DPD color reactions especially with new colorimeter glassware

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DPD Colorimetric

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DPD Interference to Consider

1. Excess residual manganese
   1. Produces a + pinkish/red
2. Excess residual phosphorus, (corrosion inhibitors)
   1. Produces a + pinkish/red
3. Ammonia
   1. Monochloramines may mimic "Free" Chlorine

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Manganese Interference

- Know what if any dissolved manganese levels present
- Generally any level at 0.05 or greater is a problem
- Causes a "positive" DPD color reaction which intensifies the Pinkish-Red color
- False free chlorine levels.

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Phosphorus Interference

- Various form of Phosphorus can be problematic
  - Blended, polyphosphates
- Adds to the DPD reagent in a "positive" reaction.
- Many public water systems utilize forms of phosphorus including Ortho and Poly
- Total water system dosage to 10ppm will be a problem.

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Ammonia Interference

- Effects those public water systems that DO NOT add ammonia as in Chloramination.
- DPD may react not only to Free chlorine, but also to Monochloramines and mimic Free Chlorine
- Water systems should determine what if an free ammonia exist in their water prior to chlorination.

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Ammonia Interference

- Measuring Free Chlorine by the DPD colorimetric method (Std Meth's# 4200-CL)
- May effect Amperometric and probe based method as well.

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Ammonia Interference Clues

- Things to look out for when using the DPD colorimetric method
  - Take Free reading at proper time window noted in manufacturer instructions.
  - Wait 15 to 25 seconds and take another reading, Reading should be stable, and about the same.
  - Does the DPD Free reading continue to increase?
  - May be Ammonia reacting with the Chlorine to form monochloramines

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Ammonia Interference Clues

- It has been reported by at least two PWS in MS while sampling noted a significant and measurable Free Chlorine
- Both had Total Coliform hits.
- DE water system reported an "unstable" Free reading. Free reading continued to rise
- Use care in defining this problem.

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Recognize Ammonia issues

- Can consume Free chlorine, give false results with DPD method
- Excess ammonia + Nitrifying bacteria can in combination with oxygen begin……Nitrification
- Nitrification may alter your water chemistry by consuming alkalinity, potentially reducing pH
- Effect Lead/copper tests.

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Infrastructure Age & And The Need For Increased Surveillance

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Case History Infrastructure Age

- In May 2000, a waterborne outbreak sickened 2,300 and killed 6 in Walkerton, Ontario.
- Heavy rainfall that washed cattle manure into a shallow well is believed to be the source of *E. coli* 0157:H7
- and *Campylobacter*.

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Case History, Infrastructure Age

- September, 1999, one of the largest waterborne outbreaks occurred in New York State
  - Over 1,000 people affected, > 60 hospitalized and 2 deaths (a 3-year-old girl and a 79-year old man).
  - Water contaminated by cattle manure which seeped into a non-chlorinated well at a County Fair following heavy rains. The well is 20-feet deep and 83 feet from the edge of a barn where cows on exhibit are housed.

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Alamosa Salmonella Outbreak

- An outbreak of waterborne disease associated with *Salmonella* in drinking water struck Alamosa, Colorado during March and April 2008.
- The city of Alamosa's public water system that supplies drinking water to the community became contaminated with *Salmonella* bacteria.
- Alamosa's population is about 8,900 people. The outbreak resulted in 442 reported illnesses, 122 of which were laboratory-confirmed, and one death.

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Alamosa Outbreak Conclusions

- Epidemiological estimates suggest that up to 1,300 people may have been ill. Details on the epidemiological investigation are pending publication by the CDPHE Disease Control and Environmental Epidemiology Division.

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Alamosa Outbreak Conclusions

* Although there were several possible causes of the outbreak
* The conclusion is that an animal source of fecal contamination entered the Weber Reservoir, and then spread throughout the entire system.

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Alamosa Outbreak Conclusions

* The Weber Reservoir is a ground-level water storage reservoir near the Weber Well, which was the primary water well in use by the city, prior to the outbreak.
* The Weber Reservoir had several small cracks and holes that likely allowed the contamination to enter. These breaches may have existed for a relatively long period of time

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Following MO Rural Water Assn. Details What Every Must Check

* These 3 systems represented what nearly every system must respond too
* All 3 issued boil orders
* All 3 failed to understand how system age played a role here.

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MO Rural Water "Water Lines" Article……Excerpts 1st quarter 2015

* "A tank cleaning company discovered at one of the Water towers that the INSECT SCREEN on the vent pipe had collapsed which allowed Midge Flies and their Larvae to enter".
* "An abundant amount of Midge Flies were found in the tank"
* At another town, we discovered that insect screens on a ground storage tank had corroded and could allow insect to enter. Did flushing and regular chlorine residuals.

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MO Rural Water, "Water Line" Article…..Excerpts 1st quarter, 2015

* In doing other inspections, he discovered that a well did not have any conduit around the electrical wires that went to the well pump.
* The void was where the conduit was supposed to go was a two-inch gap that could allow the entrance of insects and rodents to enter the source directly.

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Things to check in your System

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Routine & Regular Inspection

- Well head (power cable, screen/vents, sampling points)
- Pipes, valves booster pumps, (overall integrity, maintenance issues)
- Storage tanks, (man-ways, access points, vents/screens
- Maintaining + pressure within all zones of the distribution systems
- Backflow preventers, operational and maintenance checks, certifications

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Other Important Inspections

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Other Valve Considerations

- Rotary valves, including the ball, butterfly, and plug valves.
- Diaphragm valve, rubber or leather inside the valve's body can be adjusted up or down using an attached stem to block or regulate the flow of water.
- Pressure-reducing valves reduce the water pressure by restricting the flow.

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Small System Valve Maintenance

- Valves may leak under some circumstances
  - Age
  - Deterioration
  - Potential contamination of public water supply
- Maintenance
  - Valve-exercising process - a routine
  - Inspected and operated annually
  - Exercised full open to full closed.

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Small System - Hydrants

- Hydrants – fire protection
- Flushing system spring/fall
- Sediments and slimes loosened washed away.
- Hydrants require an annual inspection, maintenance, and repair routine for the following items:
  - Pressure and flow;
  - Loose or missing caps and cap chains;
  - Damaged nuts or cracked barrels;
  - Lost or damaged gaskets;

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Hydrants……Continued

- Peeling or wearing paint;
- Leakage, using a listening device;
- Lubrication of threads and the operating nut;
- Adequate clearance above ground and from poles, posts, buildings;
- Gate valve condition in ON position
- Complete drainage after use.

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Small System Water Storage

- Hydro-pneumatic tanks
  - Standard pressure tank with an air/water interface
  - Captive-air tank.
- Elevated steel tanks or ground level concrete or steel tanks Equipped with:
  - Vents
  - Access hatch
  - Overflow outlets
  - drains.

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Finished Water Reservoir Vent

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No Screen on This Vent!!!

39

Don't Let This Happen

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Identifying Well Problems

- Observe and record pump pressures and flow
- Loss of output from well
- Check for abnormal noise or vibration
- Bearing noise
- Proper lubrication levels
- Excess heat, (pump & motor)
- Excess leakage around packing

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Troubleshooting Declining Well Yield

- Poor pump performance (see previous slide) Flow & Pressure output checks
- Clogged screen- cleaning and scouring
- Static water level, pumping water level and the total water pumped should be recorded weekly.
- Integrity of sanitary well seals checked
- Potential corrosion issues checked

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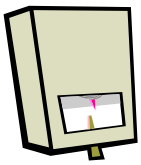
Maintaining Pressure in Small System

- Size distribution mains to maintain 35psi minimum
- Normal pressures 50 to 60psi
- Absolute minimum 20psi
  - Back-siphon age
  - Potential contamination
- Pressures above 100psi minimized
  - System wear & tear



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Small System Internal Repairs Protocol

- Isolate affected area to be opened
- Public notification
- Adequate work area
- Repair clamps & other repair items disinfected with Bleach prior to installation
- Calcium Hypochlorite granules placed inside repaired area prior to repair clamp
- Chlorine contact with repaired area for as long as possible, then flushed
- Coliform samples taken and confirmed.

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Small Water System Distribution

- Include plastic, ductile iron, steel, concrete and asbestos-cement pipe
- Valves regulate the flow of water, reduce pressure, vacuum relief, blow off, drain water from parts of the system and prevent backflow.
  - Gate valves are used to isolate sections of the distribution system……start and stop the flow of water

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Well-Head Protection

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Water Stagnation & Increased Bio-film formation may lead a pathogen outbreak

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Can Stagnated Waters Be A Health Issue in Public Waters?

- Presence of coliform bacteria indicates influence from a source - human activity, fecal material, soil, water, grain
- Stagnation of water - environment for reproduction of bacteria allowing great enough numbers to be detected

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Water Age/Stagnation

- Increased risk, the system may develop disinfection resistant bacteria…….Legionella
- Increased public complaints due to taste and odor.
- Other biological issues like Nitrification might occur with the right set of conditions.
- Stagnant water or long detention time promotes loss of chlorine residual, and higher DBP formation

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Presence of Emerging Pathogens

- Legionnaires Disease
- Cocksackie Virus outbreak
- Freshwater Brain-eating tissue Amoba
- Blue/Green Toxic Algae
- Salmonella (food born, Right?) (Alamosa, Colorado, 2008)

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Water Stagnation Issues

- Temperature monitoring
- Controlled release of water spray
- Avoid temp. conditions 20 - 45° C
- Avoid water stagnation
- Avoid materials which harbor bacteria
- Maintain cleanliness of spray outlets
- Supplemental disinfection where necessary
- Ensure correct & safe operation of system
- Flushing lines, especially low-flow areas

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Water Age/Stagnation

* Recommendations:
  - Clean tanks at least once/5 years
  - Turn over 30 to 50% of tank storage daily
  - Keep less than 5 to 7 days of hydraulic retention time …decrease storage while meeting fire protection requirements

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What is Legionella

- A naturally occurring bacterium
- Found in most water systems
- Often present in mains water
- Easily colonises most domestic water systems – hot and cold

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Needed to Grow?

- Optimum temperature range of 20 - 45 °C
- Food source (other bacteria & sediments)
- Prefers stagnant conditions

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Legionella Illustration

An illustration of Legionella bacteria, the cause of Legionnaires' disease (Roger Harris / Science Photo Library)

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Transmitted?

- Primarily through inhalation of aerosols, fine droplets & mists
- Can be contracted by choking on contaminated water
- Statistically most susceptible
  - 50 to 70 year old
  - Males
  - Smokers

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Commonly Occurring

Killer disease spreads

Health chiefs hunt for Legion bug in West End

SHOP DEATH BUG DANGER

Sales shoppers in bug alert

Hunt for killer bug

MPs in row as Legion bug strikes

Legion outbreak experts close in

Thousands could be affected by outbreak legionnaires' virus

Race to find a killer

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Recent Occurrence

inside

The Review

Regional plans
See Page 1B

www.reviewonline.com

WEDNESDAY, OCTOBER 31, 2018

75 cents

Four cases of Legionnaire's confirmed

Review Staff Reports

HANCOCK COUNTY

CHESTER, W.Va. – Four cases of Legionnaire's disease have been confirmed in Hancock County by the county Health Department following media reports of an illness taking place at Mountaineer Casino Racetrack and Resort.

Jackie Huff, the county health department administrator, confirmed lab results for four individuals tested positive for the bacteria that causes Legionnaire's disease.

The department, she said, has received additional calls about the health issue, but added it's still unclear at this point as to where the disease may have originated.

"We are receiving a lot more calls," Huff said, adding there's "no evidence at this point" that links the outbreak to the track.

"We have four cases in Hancock County, but I can't say any of them are at Mountaineer" she said.

The Daily Racing Form (drf.com) reported at least one Mountaineer employee is among the four individuals diagnosed with Legionnaire's, but Huff said federal privacy regulations prohibit her from discussing their cases or revealing their identities.

Investigators are interviewing the four individuals known to have contracted Legionnaire's to ascertain where they've been and look for a nexus, Huff said.

She mentioned of the four who were diagnosed and hospitalized with the illness, "some are out (of the hospital), some are in."

On Monday, Huff stated the health department had received several calls regarding an individual falling ill at the Chester property, but she could not verify the particular reason.

As the health department continues its investigation into the issue, the racetrack's grandstand and clubhouse remain closed.

This past weekend, Mountaineer officials announced live racing has been suspended through Nov. 7 as the park works on "some improvements at our racetrack," although it was not clarified as to what was being done.

The casino, hotel and restaurants on the property are not affected by the closure and remain open. Horsemen, as well,

See CASES, Page 7A

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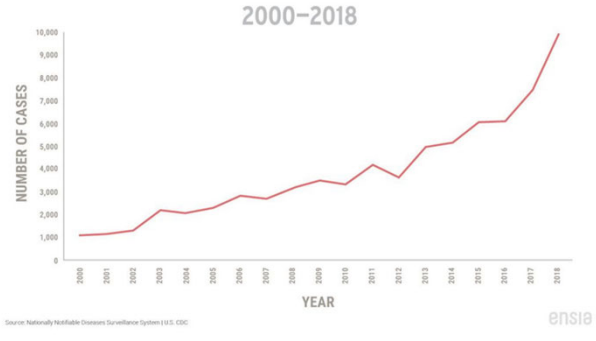
Legionella Occurrence Since 2000



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Systems at Risk?

- Cooling Towers
- Domestic hot & cold water systems
- Water features incl. ornamental fountains
- Equipment producing aerosols, mists or droplets from stored water sources including showers & humidifiers
- Equipment holding / circulating water at 20 - 45° C

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Case Histories in Maryland

- Northeast, MD: Surface water application used a pre-oxidant, (currently not operating)
- Brae Mar Condo's, Ocean City, MD: POE disinfection of Ocean City's water to control Legionella
- Princess Royale, Ocean City, MD: POE of Ocean City's water to control Legionella
- Johns Hopkins Hospital, Baltimore: POE of Baltimore City's water to control Legionella

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Other Case Histories in MD

- Legionella outbreak at a Baltimore County apartment complex, killed resident
- Another Legionella outbreak in Ocean City, MD (2014) which killed a condo resident.
- In the Maryland examples, NO EVIDENCE THE PUBLIC WATER SYSTEMS CONTAMINATION W/ LEGIONELLA

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Strategies for Controlling Water Age

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Addressing Age Issues

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Addressing Age Issues

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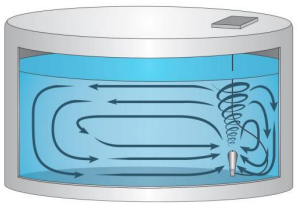
Addressing Age Issues



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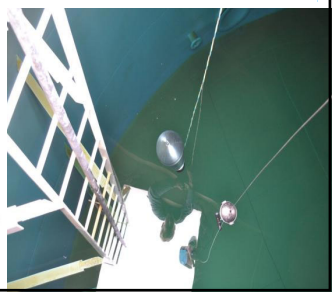
Addressing Water Age Issues



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Biofilm Issues and Strategies

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Biofilms & Bacterial Regrowth

- Complex extracellular, & excreted material that appears as a patchy mass inside pipes
- Perfect environment for microbes to attached and reproduce
- Hydraulic conditions affect amount and growth patterns.
- Attract pathogens, like Coliforms, Legionella
- Difficult to treat, and destroy with common disinfection methods.

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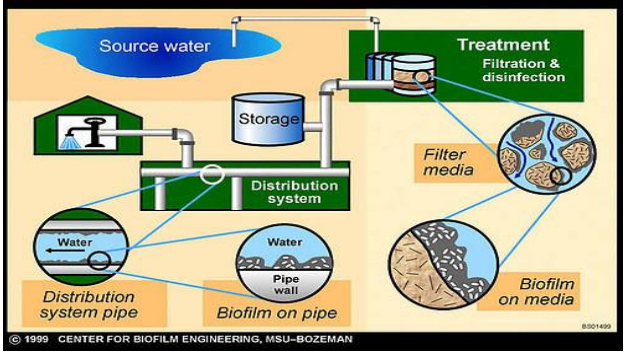
Biofilm Basics



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Biofilms in Distribution Systems

- Many different microbes have demonstrated the ability to survive in the distribution system with some possessing the ability to grow and produce biofilms.
- Water distribution system biofilm is a complex mixture of microbes organic and inorganic material accumulated amidst a microbially produced organic polymer matrix attached to the inner surface of the distribution systems

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Biofilm Examples



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Legionella Detection

- *Legionella spp.* have been detected in various drinking water biofilm
  - In drinking water distribution system
  - In sediment
  - In biofilm
  - In tap water
  - In shower water
- Examined: Quantity, Species & Variation

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Legionella & Biofilms

- The detection of *Legionella* were completed mainly using the DNA-based qPCR method in distribution systems.
- *Legionella* occurred in all the places investigated, but generally at low levels.
- The contamination could be from outside (initial source) or inside (secondary source: biofilm, sediments, etc.).
- *Legionella*, especially the potential pathogens: Lp and *L. anisa*, tended to occur in tap water and shower water when temperatures with 29-39 °C and reach high densities.

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Steps in Biofilm Development

- Trace organic material deposits on water/solid interface forming conditioning layer which allow initial attachment of material cell.
- Planktonic (free floating) bacteria approach the pipe wall and become entrained with in the boundary layer where flow velocity falls to zero result in reversible adsorption

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Steps in Biofilm Development

* Some of reversibly adsorbed cells may permanently adhere the cell to the surface and become irreversibly adsorbed.
* Biofilm bacteria excrete extra cellular polymeric substance (sticky polymers) which :

* *Hold the biofilm together.*
* *Act as nutrients for bacterial growth.*
* *Protect bacteria from biocides.*

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Biofilm Control Strategy

* Management of nutrients, (ammonia, nitrogen)
* Good solid routine & regular flushing schedule
* Controlled chloramine dose, (Monochloramines)
* Supplemental dosing with Chlorine Dioxide

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Distribution System Cleaning and Flushing Program

* Regular cleaning and flushing program in the distribution system to remove accumulated sediments and stagnant organic material/biofilm that may be reacting with the disinfectant to form DBPs.

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Ammonia/Chlorine Reactions

Combining Chlorine and Ammonia Compounds

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CHLORAMINE Disinfection

- A: Gas or liquid chlorine + ammonia
- C: Dispensed via vacuum regulators
- D: Mixing and contact time needed
- E: 5 to1 dosage ratios(approx.)

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Reaction

- Monochloramines.
- Dichloramines.
- Trichloramines, (Nitrogen Trichloride).

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Reaction Varies

- Water temperature.
- Water pH.
- Chlorine demand.
- Chlorine/ammonia ratio.

Minimize Breakpoint and trichloramines.

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Chloramine Water Chemistry

A: Forms Mono and Dichloramines.

B: Reaction is pH dependent

1) pH 9+, Monochloramines
2) pH 5 - , Dichloramine
3) Trichloramines exist past Breakpoint

C: pH 6.5 and 8.5, Monochloramines prevail

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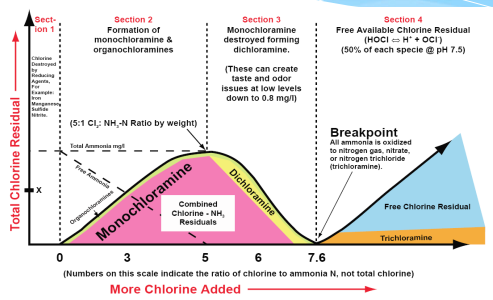
Breakpoint Chlorination Curve



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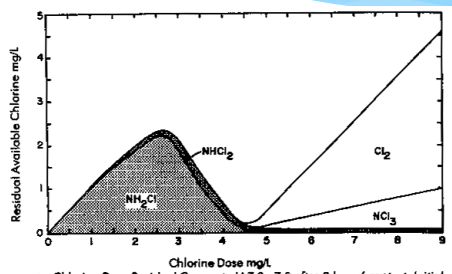
Example Reaction



Chlorine Dose-Residual Curve at pH 7.3 - 7.5 after 2 hours' contact. Initial Ammonia — 0.5 mg/L(N).

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Supplemental Disinfection With Stronger Oxidizers

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What is Chlorine Dioxide?

Chlorine dioxide is part of a family of chemicals known as oxidizers which act to remove electrons from other chemicals.

Several oxidizers used in drinking water are:

- Ozone
- Chlorine gas / sodium hypochlorite, HTH
- Potassium permanganate
- Sodium permanganate
- Hydrogen peroxide
- Chlorine dioxide
- Chloramines, (Chlorine/Ammonia Comp.)

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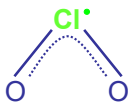
What is Chlorine Dioxide?

At room temperature, chlorine dioxide (ClO_2) is a light sensitive gas denser than air, yellow-greenish in color, soluble in water, with a chlorine like odor, is always generated at point of use.



ClO_2 Molecular Structure

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Chlorine Dioxide Characteristics

- Chlorine Dioxide small volatile & very strong molecule.
- Diluted in water, Chlorine Dioxide is a free radical
- As a gas, it is unstable, will dissociate into chlorine gas and oxygen
- Chlorine Dioxide reactions produce chloride, chlorite, and chlorate ions

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Chlorine Dioxide, Characteristics

- A synthetic, (not found in nature)
- Green-yellowish gas with chlorine-like odor.
- Chlorine Dioxide is a neutral chlorine compound
- Very different from elementary chlorine
- Both in chemical structure and behavior

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Why Chlorine Dioxide?

- **Oxidation**
  - Iron and Manganese
  - THM and HAA5 precursors
  - Taste & odor causing compounds
  - Some color compounds
- **Disinfection**
  - Broad spectrum biocide and viricide (Inactivates Crypto & Giardia)
  - Lower CT values for compliance
  - Does not form TTHMs or THAAs
- **Effective for biofilm and algal control**
- **Enhances coagulation**
- **Chlorite residual in system inhibits nitrification**

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Chlorine Dioxide, Solubility

- High Solubility
- Does not hydrolyze when it enters the water
- Remains a dissolved gas in solution
- 10 X more soluble than chlorine
- But can be removed by CO2, aeration

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Chlorine Dioxide, Advantages

- More effective at killing viruses
- Able to attack micro-organisms even in a bio-film matrix
- Prevent formation of bio-film
- Does not hydrolyze like Chlorine or Ozone
- In diluted solutions, it remains a Free Radical dissolved gas
- Residuals may have biocide capacity for up to 48 hours.

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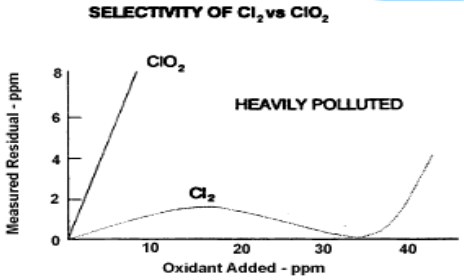
Chlorine Dioxide, Select Oxidizer



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Chlorine Dioxide & Bio-Films

- Powerful oxidizer
- Can penetrate layers of bacterial slime
- Oxidizes polysaccharide matrix that keeps bio-film intact
- Chlorine dioxide reduces to chlorite ion which then reforms due to acid conditions formed by bio-films, thus chlorine dioxide removes the bio-film remnants

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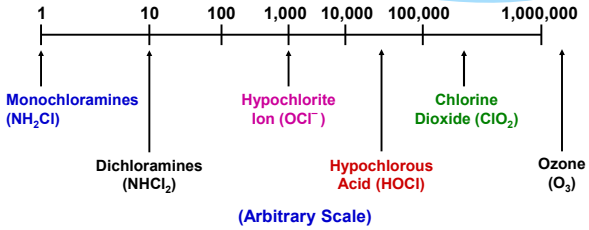
Cl_2 vs. ClO_2 – Bio-film Impact

- Chlorine does not penetrate well into a biofilm
- 1 - 2 ppm free chlorine does not prevent the growth of biofilms
- It is not possible to clean up a biofouled system by simply resuming a discontinued microbiological control program.
- A fully developed biofilm can be removed only through intensified on-line or off-line treatment.

96

Chlorine Dioxide Strength

EPA estimate of disinfection effectiveness



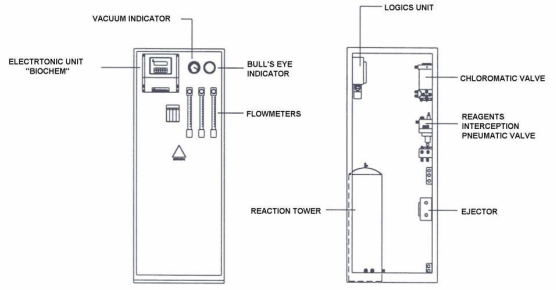
97

Severn Trent Model T70G4000

- All Vacuum
- No CL_2 Gas
- No Moving Parts (manual)
- Reagents:
  - **32% HCl**
  - **25% $NaClO_2$**
- Commercially Avail. Conc., No Dilution
- Capacities 4 to 529 PPD
- Microprocessor Control
- Manual or Automatic

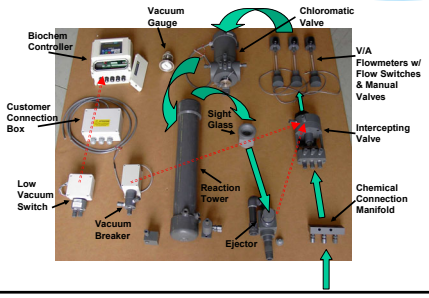
98

Severn Trent Model T70G4000 Components



99

Model T70G4000 Components



100

Chlorine Dioxide, Commercially Available Products

101

Chlorine Dioxide Dissolvable Tablets

500 PPM in 24 (90 liters) gallons water

102

Chlorine Dioxide Bulk Solution

3000 PPM solutions

0.3% available solution

NSF certified

103

Chlorine Dioxide Bulk Solution 3000 ppm Concentration

Actual containers may vary

104

Cross Connections

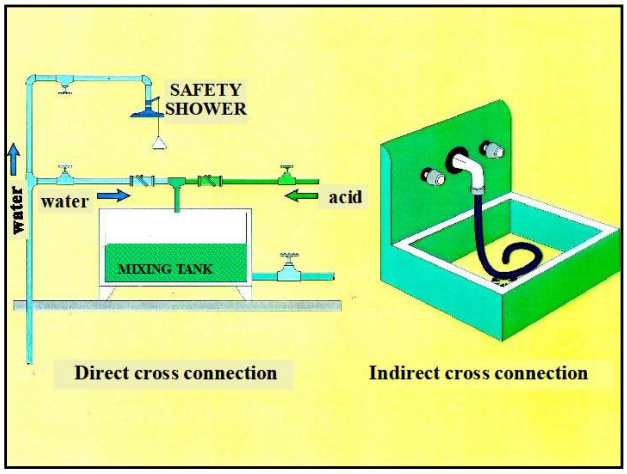
The Risk to Pathogen introduction increases geometrically here!!

105

Cross Connections

- Any link between potable and non-potable water systems that allow contamination to enter the potable system
- Contaminants can enter the potable supply when the pressure in the non-potable system is greater than the pressure in the potable system
- This pressure differential causes 2 types of backflow – back pressure backflow or back siphonage backflow
  - back pressure occurs when the non-potable system has a greater pressure than the potable system
  - back siphonage occurs when there is a vacuum in the potable system causing non-potable water to be siphoned into the potable system

106



107

108

109

110

Never Let Any Oxidizer (Chlorine, Permanganate, Peroxide) Come in Contact with Petroleum Products

111

Remember, Applies to Both Water & Wastewaters!!!

112

Hazardous Issues to Avoid With Oxidizers'

- Contact with organic compounds like oils, greases, fuels
- Contact with ammonia compounds – potential fumes & gas production
- Contact with strong acids – (elemental chlorine produced)
- Never, ever tolerate "drip-leaks" from pipe joints, seals, etc when dealing with Sodium Hypochlorite

113

Chemical Handling Precautions

- Containers closed & covered when not in use
- Adequate ventilation, respiratory protection
- Avoid a fumes
- Avoid contact with skin or eyes
- Wash your any contacted area
- Avoid contact of oxidizers w/ wood paper fibers, spontaneous combustion may occur

114

Product Awareness

115

Living Proof about "Bleach" (E-mail)

* Hey Mike this is Gary at the Village of Bellaire…thought you might be able to use this story…..can't make this stuff up….village is looking to purchase a valve turning machine and wanted to go view one in action and was directed to a nearby small village who has one…during the process we were also treated to a plant tour…small plant less than 100,000 gpd using that dam bleach for a primary disinfectant….use less than 1 gallon or 10 pounds per day….I asked why he kept so many empty barrels setting around and he responded they were full about 5 full plus the one they were working off ….I asked if he was worried about the strength of the product because it breaks down so quickly he said he knew it was mixed at approx. 15% and packaged but quickly broke down to about 12 % by the time he received the product (remember 5 full barrels and use about 1 gpd maybe 2 if they felt they needed)……**they have a system…since it takes so long to use and they knew it broke down they only use half a barrel and seal it up and start a new barrel use half of it…..they were told at some point in the past that due to the length of time the barrel is open it probably breaks down to 6-7 %…..sooooo they take both half barrels dump them together and use it up…..approx. 6% PLUS 6% EQUALS 12% THEY ARE ALMOST BACK TO FULL STRENGTH** …..why didn't I think of that….they have never had a bad bac-t dam they are good…its no wonder the EPA tells me that hypo is the way to go…got living proof

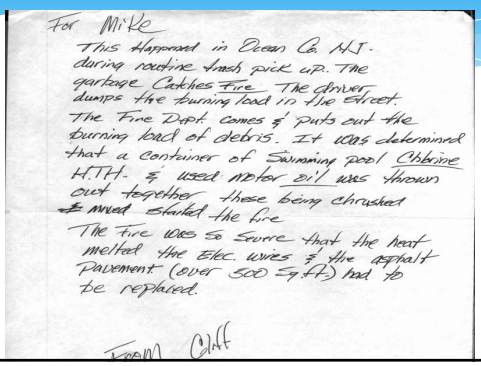
116

Murphy's Law

* Put the Right set of conditions in place
* Anything can go wrong!!!!!

117

"Murphy's" Law Applies Here!!



For Mike
This Happened in Ocean Co. NJ.
during routine trash pick up. The
garbage Catches Fire. The driver
dumps the burning load in the street.
The Fire Dept comes & puts out the
burning load of debris. It was determined
that a container of Swimming pool Chlorine
H.T.H. & used motor oil was thrown
out together these being chrushed
& mixed started the fire
The fire was so severe that the heat
melted the Elec. wires & the asphalt
Pavement (over 500 Sq Ft) had to
be replaced.
From Cliff

118

Kent County, MD
Ton Chlorine Cylinder

Found on the Beach in Tolchester, MD

119

Ohio Wastewater Plant "Would Your Consider this to Be a Catastrophic Event"

120

121

122

123

124

125

126

127

128

129

Why Did This Happen?

Don't 150's have a safety feature that prevents this?

130

Chemical Delivery Errors

131

Martinsburg, WV (Recent)

Chlorine gas clears downtown Martinsburg

By MATTHEW UMSTEAD
mumstead@herald-mail.com

MARTINSBURG, W.Va. – A chemical-related incident at the Martinsburg Wastewater Treatment Plant on Monday morning prompted an evacuation of the historic downtown Martinsburg area and nearby neighborhoods.

The evacuation that was in effect Monday about a half-mile area around the plant in the 500 block of East John Street was to remain in effect into Tuesday morning while a response team and authorities with the Environmental Protection Agency worked to remove the hazard, emergency officials said.

Authorities went door-to-door to evacuate people after the incident occurred about 8 a.m. Monday.

Orchard View Intermediate School off Delmar Orchard Road was being used as an emergency shelter by about 125 people who were being provided accommodations as of 11:30 a.m. Monday, Berkeley County Office of Homeland Security and Emergency Management Director Eddie Gochenour said.

The American Red Cross helped oversee shelter operations and Berkeley County Schools staff provided food to those sheltered, officials said.

Gochenour said it was his understanding that a mixture of chlorine gas was created when two products used at the treatment plant were accidentally mixed together about 6 a.m.

"The gentleman put the product in the wrong tank," Gochenour said.

The accidental mixture of sodium hypochlorate and ferric chloride occurred during a transport tankes offload, officials said.

While the incident created a haze and a pungent odor, authorities found "a very low percentage of gas," Gochenour said.

"We've had test strips all over the area — no indication [of chlorine gas] on the test strips until we get right down near the truck at the sewer treatment plant," Gochenour said.

A Washington, Pa., company arrived about 4 p.m. to "neutralize" the product, according to public safety officials.

Berkeley County public safety officials said the emissions should only result in a mild respiratory irritation and that residents should not experience delayed or long-term effects.

However, residents who experience nausea and vomiting should seek immediate medical attention.

Downtown streets were barricaded and intersections were blocked with emergency vehicles as firefighters and police canvassed neighborhoods and businesses.

Evacuations occurred as far west as Raleigh Street, as far north as Race Street, as far south as South Street, and as far east as the Prentiss Point residential development.

In the cafeteria at Orchard View Intermediate, Dave and Debbie Stellato said a fireman and a police officer knocked on the door of their South Maple Avenue home about 8:45 a.m.

The couple came to the shelter with Debbie Stellato's mother, Betty Dunlap, and their dog, Coco, but had no way to take their cars, all evacuees, with them.

"We're really upset," Dave Stellato said.

Debbie Stellato said she thought the odor was coming from cleaning solution because the had just done some house cleaning on Sunday.

"It never crossed my mind it was [potentially] hazardous material," Stellato said.

Photos by Matthew Umstead

Above, Police and fire vehicles block the intersection of King Street and South Queen Street after a chemical-related issue at the Martinsburg Wastewater Treatment Plant on Monday morning prompted the evacuation of multiple homes in the area of the facility in the 500 block of East John Street. At right: A haze hangs over South Queen Street.

132

A haze hangs over South Queen Street Monday morning after a chemical-related issue at the Martinsburg Wastewater

133

Gochenour said it was his understanding that a mixture of chlorine gas was created when two products used at the treatment plant were accidentally mixed together about 6 a.m.

"The gentleman put the product in the wrong tank," Gochenour said.

The accidental mixture of sodium hypochlorate and ferric chloride occurred during a transport tanker offload, officials said.

134

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Drinking Water Chemical Incident Alert

The following alert is being sent to representatives of public water supplies that may purchase chemicals for water treatment.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) recently learned of an incident where the wrong treatment chemical was delivered to a public water supply and was mislabeled. The incident posed a serious risk to the safety of the water plant operator, the drinking water quality, and was confirmed to cause equipment damage. Fluorosilicic acid (fluoride product) was ordered by the water supply and the shipping containers at the time of delivery were labeled as such. However, the product in the containers received was determined to be a high concentration of sulfuric acid. We understand the chemical was supplied by PVS from their Detroit facility and the LOT number was L091520P. This serious incident is being investigated by the chemical supplier and has been referred to NSF for investigation. To date, EGLE has not received the results of either investigation nor has EGLE been able to confirm which other water supplies received this LOT number.

The purpose of this notice is to alert any water supplies using chemicals from PVS to make sure to check the chemicals received to ensure it is the same product and strength that was ordered. If water supplies have questions about a specific chemical order, please contact PVS at 313-921-1200.

Finally, this incident is an important reminder for water supplies to review their standard operating procedures for chemical delivery and chemical releases. This presentation as well as this excerpt of an AWWA training video contain chemical receiving guidance. If you have general questions, you may contact Mike Bolf, Engineering Unit Supervisor with EGLE's Drinking Water and Environmental Health Division at BolfM@Michigan.gov or 906-630-4107.

135

Always Verify Most Every Chemical Delivered To Your Water or Wastewater Facilities

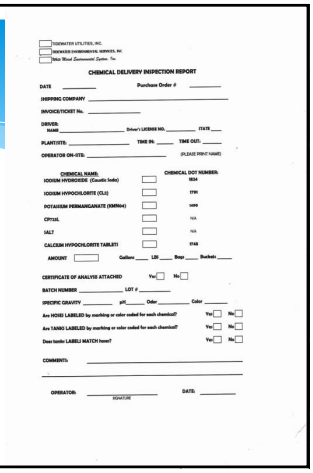
136

Advantages of Verification

- Confirm product received is product ordered
- Confirm product conformity to purchase specification
- Detect underlying issues with product, (sedimentation, color, odor prior to introduction into the process
- Ultimately save your facility from a potential catastrophic event

137

Chemical Delivery Ticket, Example



CHEMICAL DELIVERY INSPECTION REPORT

138

Delivery Errors?

- A Salisbury, MD Industry received wrong chemical, it's use caused worker injury
- A Vermont public water system received 3 drums of Hypo…….one was mislabeled, it contained hydrochloric Acid, sent both water operators to the hospital
- A Tennessee water facility received 6 drums of Fluorosilicic Acid, one was mislabeled, it contained a petroleum-based cleaning solvent

139

Delivery Errors?

- A Western MD city received drums of "presumed" Sodium Hypochlorite, mislabeled, it contained a wastewater de-odorant
- A So. Maryland Wastewater Facility received a chemical delivery and off-loaded to a "wrong" storage tank, causing a" huge exothermic reaction"

140

Oxidizers Decay In A Short Time

- Decay, a function of:
  - Oxidizer concentration
  - Temperature of the solution
  - Contact w/ metal impurities
  - pH of hypo solution
  - Exposure to light
  - Overall ionic strength of the solution

141

Minimizing Deterioration

- Dilution – a 1-1 dilution will lead to 5-fold reduction in decay rate
- Climate control
- Product life cycle
- Maintain routine delivery cycles
- Always uses the weakest strength solutions possible, based upon needs

142

Sodium Hypochlorite Handling in the Water/Wastewater Facility

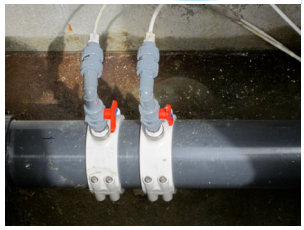
143

"Drip-Leak" Potential Hazards

- "Drip-leaks/seal leaks may solidify & dry out completely
- Powder may contain Sodium Chlorate
- If impacted with hammer during maintenance, could ignite or explode
- Any clothing with Chlorate dust runs a risk of ignition
- Special care by washing/diluting all powder formations to minimize

144

Hypo Drip-Leaks & Deposits

145

Hypo Drip-leaks & Deposits


146

Things to Watch Using HOCL

- Bleach solutions, especially higher concentrations, that are allowed to dry completely
- Can contain sodium chlorate crystals. For example, as bleach around pump seals dries and decomposes
- White powder can contain higher levels of sodium chlorate in addition to sodium chlorate solids. This is due to the elevated temperatures

147

Things to Watch Using HOCL

- If the dry powder does contain higher levels of sodium chlorate and it is impacted, such as being struck by a hammer,
- The chlorate may explode or ignite and seriously injure anyone nearby.
- If this powder is present, wash the equipment and the area with large volumes of water into a drain.

148

Things to Watch Using HOCL

- Run extra water to thoroughly flush the drain. Any clothing or shoes that are contaminated with a solution that may contain sodium chlorate.
- Must be washed immediately before they dry. Any spark or heat source can ignite cloth or shoes
- If significant residual sodium chlorate is present when the item dries. Shoes may need to be soaked in water for extended periods.

149

Hypo Spill Management

1. Leak mitigation
2. Containment
3. Recovery

If any of the above are fail

4. Absorption – Do not use sawdust!!!
5. Dilution
6. Neutralization

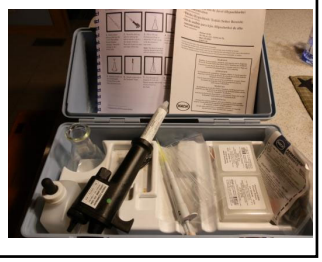
150

Product Strength Measurements

- Initial strength measurements
- Confirm delivered strength
- Determine rate of deterioration over time
  - calculate initial dose
  - Calculate dose over variable flow conditions versus strength

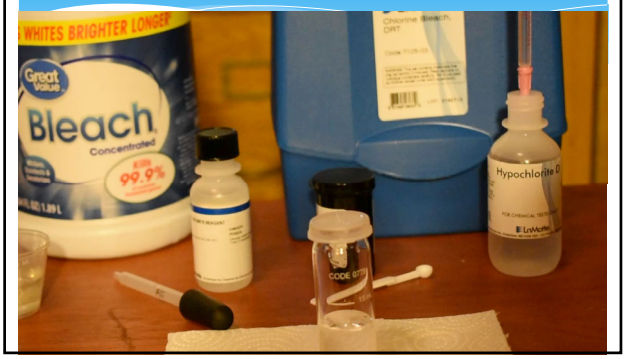
151

Direct Chemical Kits



152

Direct Chemical kit Demo



153

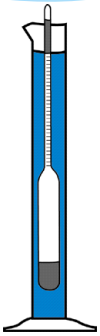
Measuring Chem. Characteristics

- **Strength .**
- **Specific Gravity**
- **pH**
- **Color/viscosity**

154

SG Chemical Strength

Hydrometers



155

Hydrometer Sequence Basics

Lower Bulb into Hydrometer cylinder Sample

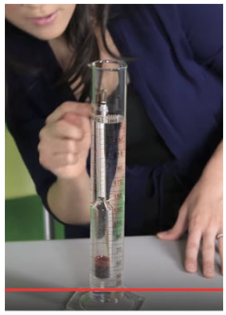
Gradually lower Bulb Weight Down

156

Hydrometer Sequence Basics

Wait For Bulb To stabilize

Read Bulb Scale



157

What Does this Hydrometer Bulb Read?

158

Specific Gravity Measurements

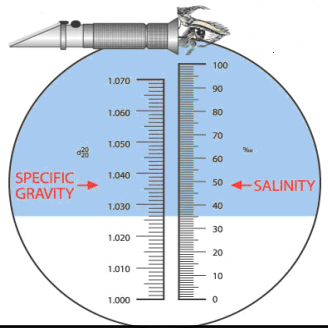
Refractometers

159

Refractometer Use Demo

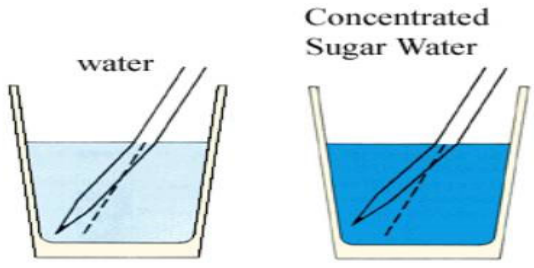
160

Reading A Refractometer



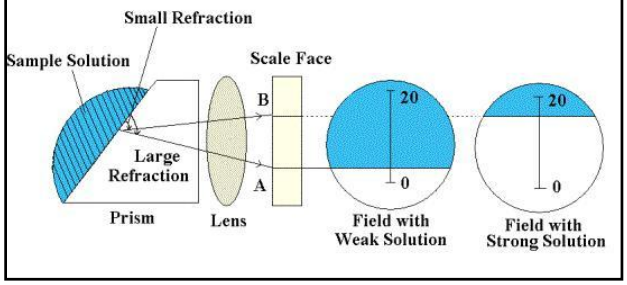
161

Principles of Refractometer



162

Principles of Refractometry



163

Specific Gravity by Weight

- 10 mL sample in a weighing bottle
- Analytical weight measurement to 4 decimals places
- Divide the measured weight by 10
- Result represents Specific Gravity
- Convert to % available Chlorine
- ***Note: This method can used to measure SG of any liquid chemical***

164

Dry chlorine (HTH) needs to be dissolved in water to accurately Feed

165

Storage – Dry Chlorine

- Store product in a cool, dry, well-ventilated area.
- Store away from combustible or flammable products.
- Keep product packaging clean and free of all contamination, including e.g. other pool treatment products, acids, organic materials, nitrogen-containing compounds, dry powder fire extinguishers (containing mono-ammonium phosphate), oxidizers, all corrosive liquids, flammable or combustible materials

166

Handling Issues – Dry Chlorine

- **Fire Extinguishing Media:**
- Use flooding quantities of water as fog or spray. Use water spray to keep fire-exposed containers cool.
- Avoid direct contact with water; reacts with water releasing chlorine gas.

167

Handling Issues – Dry Chlorine

- Fight fire from protected location or maximum possible distance.
- Do not use dry chemical fire extinguishers containing ammonium compounds.
- Do not use carbon tetrachloride fire extinguishers

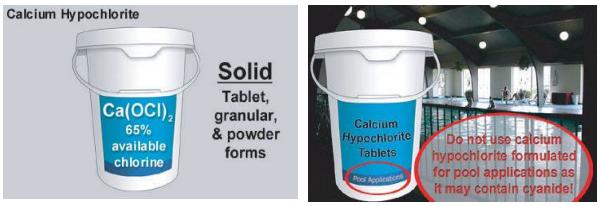
168

If you purchase Hypo or Solid Chlorine from a Pool Store?

- Caution needed in the correct selection of product
- NSF Certification for use in potable waters?
- Avoid "stabilized" pool chlorine compounds
- Stabilizer may contain a Cyanide compound
- Should never be introduced to a Public Water System as disinfection.

169

Calcium Hypochlorite & Pools



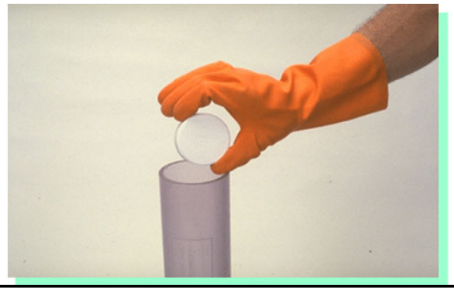
170

Solid Dry Chlorine

- Granular, Powder, Tablet
- 65 to 70% Free Chlorine
- Dissolved in Water, then Fed via Chemical Feed Pump
- Labor Intensive to Prepare and Handle
- Sodium Fluoride - Solids

171

Dry Tablet Chemical

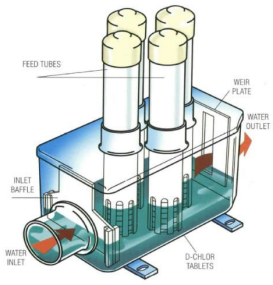


172

Tablet Dispensers

173

Tablet Dispensers



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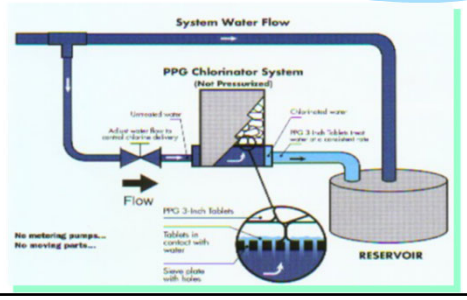
Tablet Dispensers

175

Tablet Dispenser Diagram



176

Verifying Deliveries Of Dry chemical

- Uniform color
- Uniform Consistency
- Granular size
- Evidence of Clumping?
- Any evidence of contamination?
- Some solid Chemicals must be dissolved in water to be fed

177

Always Use the Weakest Practical Strength of a Chemical Solution in Your Water Wastewater Plant

178

Advantage to Lower Strengths

- Safety and handling issues decrease with strength
- Deterioration of chemical tend to decrease with strength
- Operational problems tend to mitigate, (off-gas, corrosive atmosphere, loss-of-pump prime)
- Greater selection of chemical pumps with lower concentration of chemical

179

Chemical Deterioration

- Time
- Environmental issues
- Moisture
- Agitation
- Off-gas hazards

180

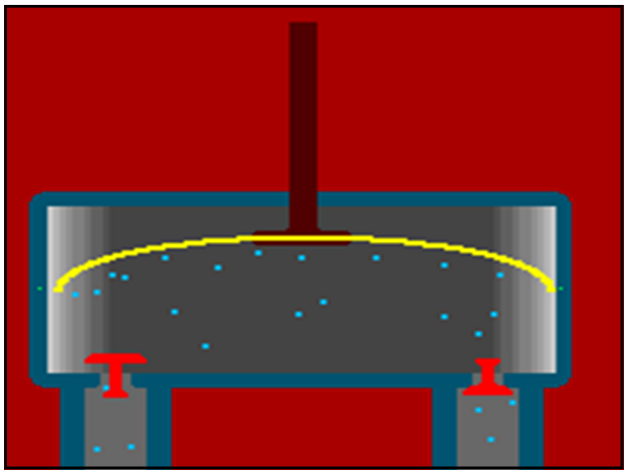
Chemical Dispensing Issues

- Product deterioration
- Manufacturing/delivery consistency
- Limiting chemical residuals
- Maintaining proper doses, (manual or automated control systems)
- Dispenser selection, maintenance
- Regulatory mandates,(minimizing byproducts)

181

Diaphragm Chemical Pumps

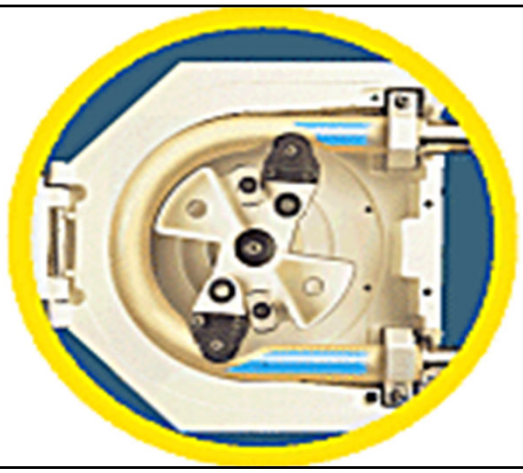
182



183

Peristaltic (Tubing) Pumps

184



185

Common Chemical Problems

- Deterioration
- Concentration
- Temperature of the solution
- Contact w/ metal impurities
- pH of chemical solution
- Exposure to light
- Overall ionic strength of the solution

186

Weakest Strength Chemical Can?

- Help mitigate chemical feed system leaks
  - Pump selection, piping system joints consideration
- Chemical off-gassing- loss of prime
  - Simple solution……DILUTION!!!!
  - Degassing valves, (stop the off-gas, degassing valve?)
- Residuals measurement repeatability
  - Proper mixing
  - Mechanical
  - Static mixing

187

Conclusions to Draw

- It's extraordinarily easy to introduce pathogenic microbes into a H20 system
- Follow all repair protocol, especially disinfection techniques in repairs
- Do a routine inspection for breeches in your hardware due to age
  - Pay particular attention to screens and vents
- Watch your DPD test protocol and know of any potential interference that can cause errors.
- Watch routine issues with backflow devices, growth of biofilms

188

Conclusions, Continued

- Replace your DPD glassware routinely and watch out or interferences
- Address any water age or stagnation issues…even a simply pump moving your water helps
- Be sure to check those screens, seals, and manways for decay
- Verify most every chemical delivery to avoid mistakes and mislabeling.
- Always use the weakest practical strength chemical at your facility
- Don't forget even the simplest backflow conditions still exist today……the hose.

189