Screening Water and Wastewater for Safety, Security, and Toxicity

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Screening Water and Wastewater for Safety, Security, and Toxicity

WWW 5710

7 contact hours

9 CC10 hours

Description

The activated sludge process has limitations when handling toxic influents of unknown origin and strength. Once the bug population is destroyed or inactivated due to toxicity or high BOD loading, regrowth is a painful time consuming process. Time is of the essence when this occurs, so an immediate screening of the process can provide real-time information for decision-making. Simple screening tools will be discussed, such as: chemical oxygen demand tests, quick biological scans, rapid biological toxicity screening, and oxidation reduction potential (ORP). Participants will also discuss how quick screens of key areas of their water system for safety and security vulnerabilities can be beneficial; examine how case-histories and low-cost ideas and applications can be used to monitor strategic areas of their water system, and how these tools can be used as an early-warning mechanism to prevent disinfection residual violations, or assess the system for intrusions. Monitoring system components, applications and integration from hardware to data acquisitions and transmission will also be covered.

Learning Objectives

1) Identify the limitations of the activated sludge process when handling toxic influents.
2) Discuss ways to strategically monitor water and wastewaters for intrusions.
3) Explain why simple measuring tools like ORP, COD, and Oxygen uptakes are beneficial when making quick decisions when the bug population is inactivated due to toxicity.
4) Discuss how a measurement like ORP may provide an early-warning tool for distribution systems.

Outline

I) INTRODUCTION (30 Minutes)
- a) Early warning monitoring
- b) Low in cost
- c) Easy to install & maintain
- d) Generate continuous surveillance data
- e) Promote general health of the water/wastewater system (Negative transient pressure)

II) SAFETY/SECURITY ISSUES (60 Minutes)
- a) Most venerable part of the water system
- b) Miles of unattended pipeline

c) Potential easy access
d) Meters, Hydrants, Back-flow preventers
e) Potential for selective contamination

III) POTENTIAL CONTAMINATIONS & UPSETS (60 Minutes)
a) Biological
b) Chemical
c) Mixed Liquor toxicity/inhabition

IV) COMMON SENSE APPROACH
a) Limit access
b) Limit venerability
c) Low-cost hardware
d) Simple to maintain
e) Accountability

V) KEY MONITORING PARAMETERS (60 Minutes)
a) That indicate change in water quality
b) But not necessarily be a hazard
c) Measuring these key parameters at key locations in wastewaters waters & distribution systems

VI) KEY MEASUREMENTS (60 Minutes)
a) Oxidation Reduction Potential (ORP/Redox)
b) Conductivity/TDS
c) Chemical Oxygen Demand
d) Oxygen Uptakes Rates, (DOUR/SOUR)
e) Basic Water Quality Measurements

VII) WORKING WITH THE KEY PARAMETERS (120 Minutes)
a) Define
b) Application in Managing the Process Verification protocol
c) Measurement apparatus
d) Typical installations

VIII) MONITORING SYSTEMS (60 Minutes)
a) Instrumentation
b) Verification
c) Installations
d) Case History

SCREENING WATER & WASTEWATERS FOR SAFETY, SECURITY, & TOXICITY

EARLY WARNING MONITORING FOR PUBLIC HEALTH AND SECURITY

Contact Info

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- E-mail: cmhco@verizon.net
- Office: 410-928-3591

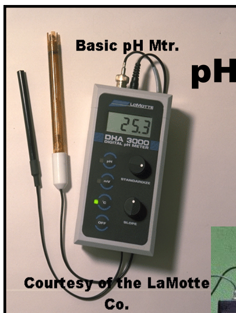
Potential Wastewater Threats

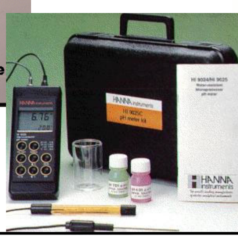
- Accidental discharges
- Toxic specific purpose discharges
- Non-point sources discharges
- "Mid-Night Dumper"

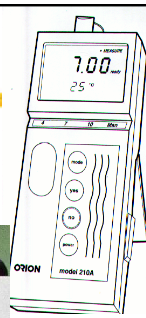
Quick Observations & Assessments

- Common Observations
  - pH
  - Temperature
  - Microbiological scans
  - Alkalinity
  - Color

pH Measuring







Identifying Organisms Under Duress, Potential Toxic Condition?

What does this mean for process control?

Cilliate Under Stress

Myoneme

Sheared Stalked Ciliate, Stressed

Stalked Ciliate Under Duress

Other Screening Assessments

- Abbreviated Chemical Oxygen Demand test
- Oxygen uptake screens (SOUR)
- Oxidation Reduction Potential (ORP)

Chemical Oxygen Demand, short-form

Chemical Oxygen Demand

- Abbreviated test for about 30 - 45 minutes, not typical 2 hrs.
- Choose Mercury, Mercury-free, Dichromate, or Manganese methods
- Test-in-tube method preferred
- Minimal sample size, smaller waste disposal issue

COD Determinations

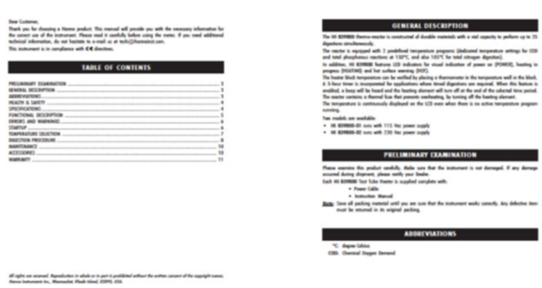
- Quickly determine high biological load, or slug
- Estimate treatability
- Quick 30 to 45 minutes screen test
- Approximate BOD loads, (ball-park COD is approx 2.5X BOD)

Chemical Oxygen Demand


Instruction Manual

HI 839800 COD REACTOR
and Test Tube Heater
2008 Series

Chemical Oxygen Demand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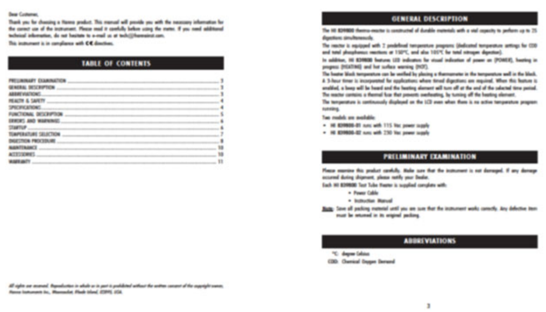
GENERAL DESCRIPTION

PRELIMINARY EXAMINATION

ABBREVIATIONS

Chemical Oxygen Demand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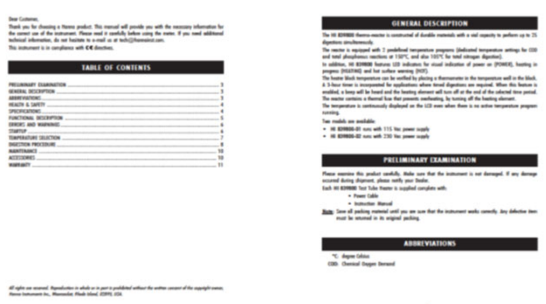
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GENERAL DESCRIPTION

PRELIMINARY EXAMINATION

ABBREVIATIONS

Toxicity Screening Via DOUR/SOUR/OUR

- The oxygen uptake test is useful in detecting toxicity.
- When toxins are present, the oxygen rate decreases.
- If extraordinary BOD loading, then oxygen uptake accelerate.
- If one knows the range of uptake rates that are normal.
- It is easy to see when toxins depress the uptake test and the results can be used to screen wastewater for toxicity

TOXICITY TESTING
POLYTOX™

- EPA recommended Test for toxicity
- Performed on a variety of biodegradable polymers
- No toxicity for the coated cups

POLYTOX™ contains specialized microbial cultures that can determine the relative toxicity of water and waste water streams in about 30 minutes, with no expensive instrumentation required. The respiration rate is the oxygen consumed by aerobic and facultative bacterial cultures and is expressed as mg of O_2 consumed per liter per minute.

Features and Benefit - Polytox

- Cost effective product
- Run with standard Dissolved Oxygen meter
- Easy-to-use
- Reliable, consistent results in less than 30 minutes
- Free of nitrifying microorganisms
- Non-pathogenic
- Available in package of 20 vials

Polytox

POLYTOX Equipment

- Standard (300 ml) BOD bottle(s).
- Dissolved oxygen probe and meter.
- magnetic stirrer or self-stirring dissolved oxygen probe suspending **POLYTOX®**
- Aeration device (e.g., aquarium pump, tubing and air stone).
- One and two liter containers to be used for aeration of the distilled or deionized water

POLYTOX Equipment

- Wastewater or chemical (test) samples.
- pH adjusting solution(s) (e.g., dilute sodium hydroxide or sulfuric acid).
- Thermometer.
- Funnel.
- Stopwatch.

POLYTOX, Protocol

- Duration/contact time: 19 and 21 minutes
- Containers: 1 liter size for the aeration of the control(s), 2 liter size for the aeration of the test(s)
- Air Supply: clean, oil-free air
- Water: Deionized and/or distilled water

POLYTOX Protocol

- Reactor Vessel: BOD bottle(s)
- Test Solution: The freshly prepared wastewater or chemical solution (e.g., aerated solution with pH and temperature adjusted)
- Control: Baseline respiration rate for the **POLYTOX®** populations only
- Temperature: 20 + 2°C.

ORP

Redox?

Redox?

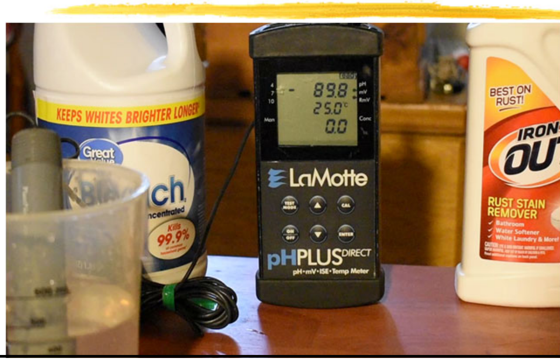
Why Redox?

Transfers of Electrons

What is REDOX(ORP)

- Oxidation Reduction Potential is………….
- *A measurement of a waters capacity to oxidize and reduce*

What's ORP All About?



Common Oxidizers We Use

- Chlorine
- Hydrogen Peroxide
- Potassium Permanganate
- Ozone
- Oxygen
- Air
- Chlorine Dioxide
- Iodine/Bromine

Common Reducers We Use

- Sulfur Based, (Sulfur Dioxide, Sodium Thiosulfate, Sodium Bisulfite)
- Anoxic
- Anaerobic
- Metals, (FE, MN, CN, AS)

The Word "Potential"

- Webster says the definition of the word "potential" is the possibility of doing something, or perform some work!

Things to Remember ORP

- Oxidizers give up electrons
- Reducers, accept electrons
- Thates interaction between Oxidizers and Reducers produces a voltage signal
- The word "Potential" means the possibility to perform work

Redox v/s Oxidation

Chlorination/Dissolved Oxygen

Down to Earth Examples

Redox Measurement

Redox Electrode

Seven Deadly Sins of Probe and Meter Measurements

- Probe /meter selection
- Proper filling solutions
- Probe storage errors
- Limiting ions and demand in dilution waters
- Infrequent calibrations
- Forgetting temperature compensation
- Reused standards/buffers

Generates Millivolts

KEY ORP POINTS

- All measurements are taken on-site
- All measurements in Millivolts (mV)
- ORP probes not typically temperature compensated.
- May take longer time window to get stabilized readings
- Expect more probe maintenance than w/ typical pH probes.

Field Redox Measures

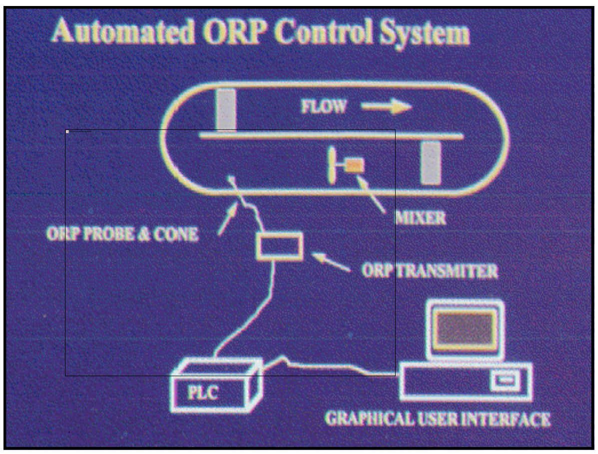
Field Redox Measures

Field Redox Measures

Process REDOX

Process Applications

- Collection system monitoring
- Nitrification/Denitrification
- Phosphorus removal
- Toxicity screening
- Chlorination/Dechlorination
- Sludge digestion



Process Instruments

Verification/Reference

Maintenance

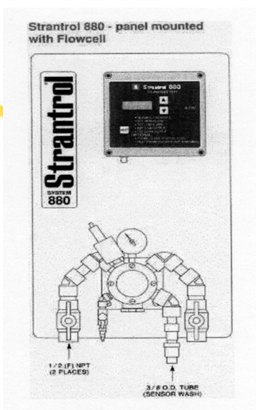
Wastewtr. Applic.

Wastewtr Applic.

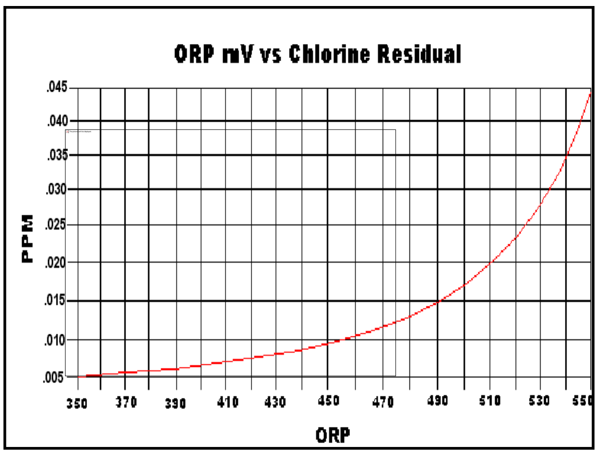
Chlorination

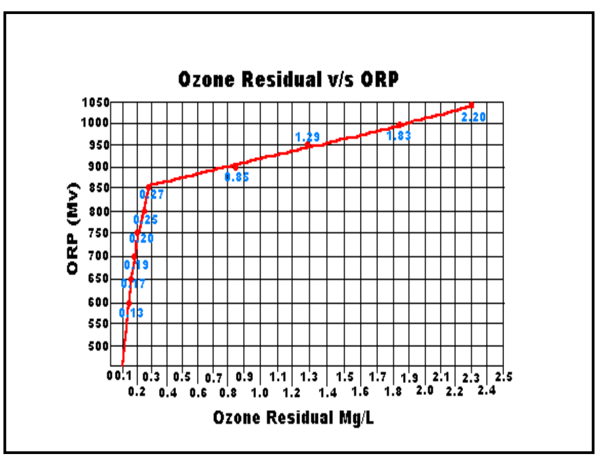
Process Disinfection REDOX

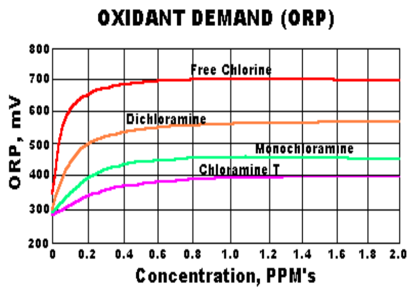
Dechlorination



Case History, Lancaster, PA


ORP mV vs Chlorine Residual
PPM
.045
.040
.035
.030
.025
.020
.015
.010
.005
350 370 390 410 430 450 470 490 510 530 550
ORP


Ozone Residual v/s ORP
ORP (Mv)
1050
1000
950
900
850
800
750
700
650
600
550
500
0.13
0.17
0.19
0.20
0.25
0.27
0.85
1.29
1.83
2.20
0 0.1 0.3 0.5 0.7 0.9 1.1 1.3 1.5 1.7 1.9 2.1 2.3 2.5
0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4
Ozone Residual Mg/L

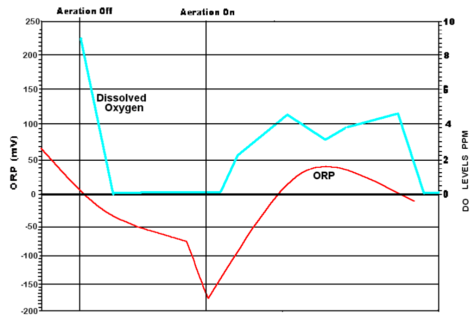


(US Filter/Stranco, 1998)

Phosphorus Removal

- Aerobic and Anaerobic process
  - Anerobic zone releases phosphorus (bacteria)
  - Aerobic zone absorbs (bacteria)
- Target REDOX:
  - Anaerobic Zone: -200 to -300 mV
  - Aerobic Zone: > +100 mV

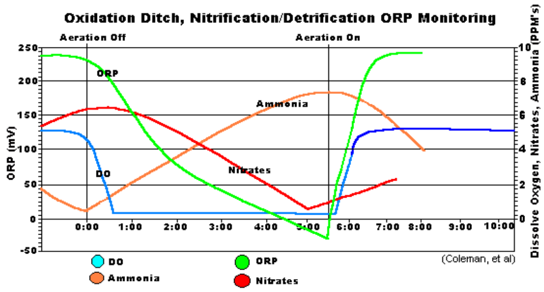
Phosphorus Removal Oxidation Ditch



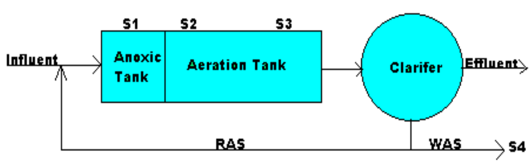
Biological Nutrient Removal

Biological Nutrient Removal

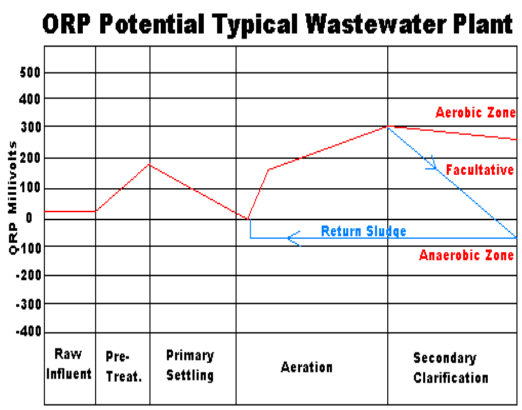
BNR Applications



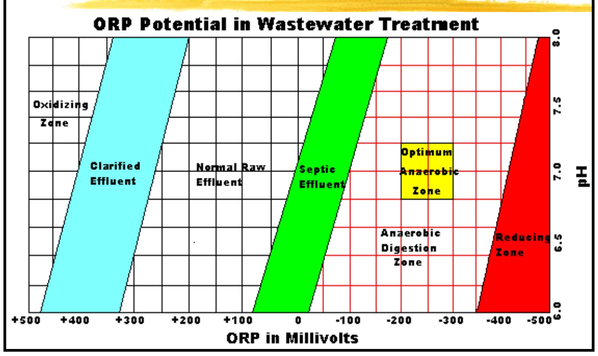
BNR REDOX Sampling



General Monitoring



REDOX/pH Comparison



Toxicity Screening

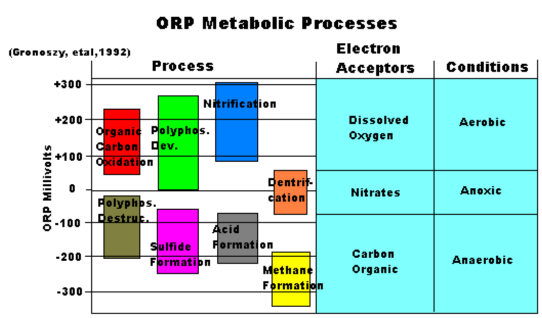
Odor Control

Anaerobic Sludge Digestion

Aerobic Digestion

Organic Carbon Reduction

Typical REDOX Potential



Industrial Wastewater

Industrial Wastewater

Case Histories

So. Berwick, ME

So. Berwick, ME

So. Berwick, ME

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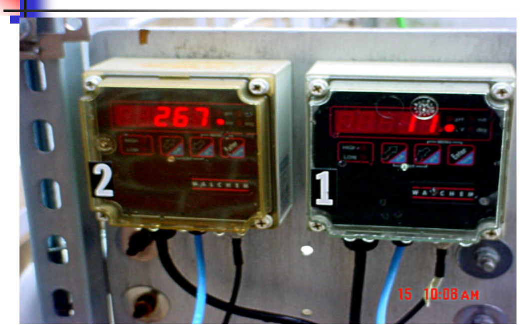
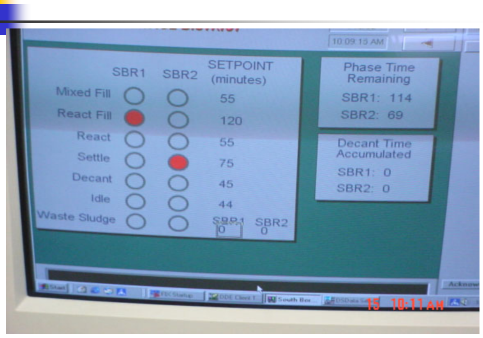
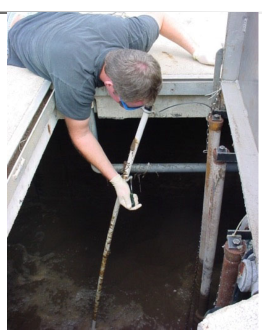


So. Berwick, ME



St. Clairsville, OH

St. Clairsville, OH



St. Clairsville, OH

Town Of Zillah, WA

BNR Control - Off

DO/REDOX

Indication & Control

BNR Control - On

WASTEWATER SCREENING CONCLUSION

- Quick simple screening of wastewaters a must to avoid toxic shocks
  - Visuals, pH, temp, Alkalinity a must
  - Quick COD's. (45 minutes)
  - OUR, SOUR screens, powerful tools
  - ORP monitoring, very useful simple probe based measurement

WATER DISTRIBUTION SCREENING & MONITORING

Simple low-cost screening for basic water quality issues

Quick screening for toxics

Don't forget Cyber Security in the Treatment facility and Distribution (Operator Monitor)

Terrorist Threat?

WATER DIST. OBJECTIVES

- Early warning monitoring
- Low in cost
- Easy to install & maintain
- Generate continuous surveillance data
- Promote general health of the distribution system by assessing:
  - Water Retention time, (stagnation)
  - Slime formation and build-up

DISTRIBUTION SAFETY/SECURITY ISSUES

- Most venerable part of the water system
- Miles of unattended pipeline
- Potential easy access
  - Meters
  - Hydrants
  - Back-flow preventers
- Potential for selective contamination
- Even the small system may be venerable to terrorist threat

Digital Intrusions via Remote Access

- Unauthorized intrusions that potentially gain direct access to process controls
- Hacker's looking to upset and cause an alarm response
- Unauthorized direct access to SCADA
- Even potential terrorist threats
- The need for active operator monitoring, notification & prevention software

SCADA Intrusion, Real Example

Police say an attempt to contaminate a Florida city's water supply with sodium hydroxide has failed despite a hacker gaining remote access to the local water treatment plant's computer system.

Pinellas County Sheriff Bob Gualtieri said during a news conference on Monday that a plant worker at the city of Oldsmar's water treatment facility first noticed unusual activity with its computer system at 8 a.m. on Friday, when a hacker briefly access the system.

At about 1:30 p.m., a hacker accessed the system again, taking control of the mouse and directING it to the software that controls water treatment. The hacker then briefly increased the amount of sodium hydroxide from 100 parts per million to 11,100 parts per million.

Water System Intrusion

SCADA Intrusion Example

Sodium hydroxide, also known as lye, is the main ingredient in liquid drain cleaners. It also is used to control water acidity and remove metals from drinking water at treatment plants.

After the hacker exited the system, a worker at the plant was able to intervene and reverse the change.

"Because the operator noticed the increase and lowered it right away, at no time was there a significant adverse effect on the water being treated," Gualtieri said. "Importantly, the public was never in danger."

Gualtieri noted that even if the worker had not intervened right away, it would've taken between 24 and 36 hours to hit the water supply system and that there are other safeguards in place where the water would have been checked before it was released.

POTENTIAL CONTAMINATIONS

- Biological
- Chemical

BIOLOGICAL CONTAMINATION

High Priority	Medium Priority	Low Priority
E-coli Fecal Coliform	Staph	Brucella
Legionella Salmonella	Listeria	Hepatitis
Anthrax	Cholera	Cocksackie Virus
Blue/Green Algae Toxin	Plague	

Emerging Biological Pathogens

- Legionella, (legionnaires disease)
- Covid-19 (corona virus)
- Cocksackie virus (A & B3), Undisinfected secondary wastewater, fecal matter, fecal contaminated potable waters
- Salmonella - comes from ingesting food or water contaminated with warm-blooded animal feces.

Emerging Biological Pathogens

- Brucella – food related, but can be spread through both potables and untreated wastewater from food processor
- Blue-green algae toxin - (red tide)- surface water related, prefers elevated temperatures to re-emerg.
- Naegleria fowleria – (fresh water flesh eating amoeba)
- Toxic Cyanobacteria - health problem arising as a consequence of eutrophication.

Toxic Blue/Green Algae Bloom Lake Erie

BLOOM AND BUST
Toxic algae blooms like this one on Lake Erie in September affect public water supplies. The blooms are caused by wastewater, stormwater and agricultural runoff reaching the lake. Now farmers like David (left) and Lowell Myerholtz are turning to technology to manage fertilizers with greater precision. Here, they take leaf samples to determine plant health and identify areas of their field that need nutrients.

Simple No-Cost Blue-Green Algae Test Protocol

The jar test

If your lake or pond water appears very green, the jar test can help determine if the color is from blue-green algae, or just an overabundance of more beneficial types of planktonic algae.

Materials

- Clear jar (pint to quart size) with a screw top lid, such as a canning jar or pickle jar with label removed
- Rubber or latex gloves

Procedure

1. With the gloves on, collect a sample just below the surface of the water (avoid collecting just the top layer of scum).
2. Fill the jar about three-quarters full. Do not fill the jar completely; algae give off gases that may cause pressure buildup in the jar that could break it.
3. Wipe any scum off the outside of the jar and screw the lid on.
4. Put the jar in the refrigerator and leave it undisturbed overnight.
5. Carefully remove the jar from the refrigerator and see where the algae has accumulated. Do not shake or agitate the jar at all or the algae will mix into the water again and negate your test results.

Simple No-Cost Cyanobacteria (Blue-Green Algae) Results

6. If the algae are settled out near the bottom of the jar, it is likely that your lake does not have a lot of blue-green algae.

7. If the algae have formed a green ring at the top of the water, there is a strong possibility that your lake does have a blue-green algae community.

CHEMICAL CONTAMINATION

- VX (50ug/l)
- Sarin (50ug/l)
- Cyanide (25mg/l)
- Arsenate (100-130 mg/l)
- Acids (unk)
- Alkali's (unk)
- Arsenite (100-130 mg/l)
- Sodium Fluoroacetate (unk)

Common Sense 1st

- Limit access
- Limit venerability
- Low-cost hardware
- Simple to maintain
- Accountability

Security Hardware

Security Hardware

Security Hardware

Pump Security

SAFETY/SECURITY CONCEPTS

- Install monitoring devices
- Collect and process data over time
- Generate historical data over time
- Look for deviations from established norms
- Follow-up with confirming sample collection and lab based testing

Early Case History, Washington D.C.

- Fort Reno Tank was selected as the first location for remote monitoring system implementation
- Four water quality parameters were selected for monitoring in this Case Study - Temperature, Chlorine, Turbidity, pH
- The study was later on expanded to two other locations Bryant Street and Blue Plains
- The existing WASA's SCADA system was adapted for data collection

Overview of the Case Study

In 1996, following a number of Coliform violations EPA Region-3 directed DC Water and Sewer Authority (WASA) to implement several corrective actions

One of the corrective actions proposed was remote monitoring of water quality. In 1997, EPA initiated a study to install a remote monitoring network

System Selection and Implementation

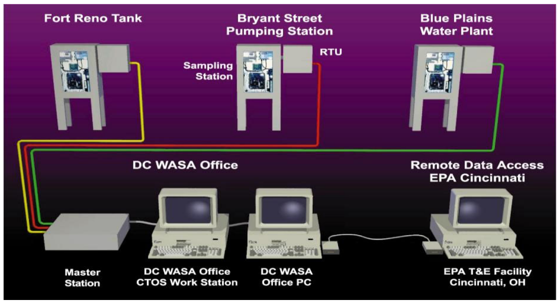
Off-the-shelf online monitoring instrumentation for Temperature, Chlorine, Turbidity and pH with 4-20 mA external outputs were used

A custom water sampling system was built for each site

A Preliminary Assessment for selecting and implementing the appropriate Data Acquisition System was performed. Key factors are outlined as follows:

- Initial and ongoing $ - EPA/WASA

Overview - System Layout



Overview – Sampling System

System Selection and Implementation

- Ease of use and programmability - Proprietary
- Hardware Networkable - Yes
- System Scalable - Yes
- Data/System Redundancy - Yes
- System Security – One Way Data Transfer
- Remote Access Capability - Not Available
- System Response Time - More than adequate
- Historical Trend Data Storage/Transfer Capability - Limited Storage
- Availability of Local Support - WASA

System Selection and Implementation

- Software Features – Graphics, Trending and Reports
- Remote Access - Added a Windows-based PC workstation to dial into using pc Anywhere/ Reachout Software (added security, prevents remote access to the WASA SCADA system)
- Trending - Export Program in Access97
- Reporting - Queries to chart in Excel97
- Power Availability - Yes

Discussion

3. How to select and implement/integrate the various SCADA system components for data collection?

a. Implement new or integrate with existing SCADA system
b. Communication media – Cable/wire, cellular, satellite, RF, etc.
c. Data collection and handling

Discussion

4. Intended use and interpretation of real-time data?
a. What do the numbers mean?
b. Do we need data filters?
- How do we verify and report the data?

5. Monitoring system maintenance and management?
a. Proper training/retention of people
b. Instrument calibration and recordkeeping
c. Commitment from management $ xxx,xxx's

Discussion

- **What parameters should be monitored, selection criteria for monitoring instrumentation?**
  a.Conventional (Physio-chemical) - pH, ORP, DO, Turbidity, etc.
  b.Biological – Daphnia, fish, clam, other
- **Both**

TWO KEY MONITORING PARAMETERS

- That indicate change in water quality
- But not necessarily a hazard
- Measure these two key parameters at key locations in the distribution system

LOCATION SELECTION PROTOCOL

- Easy installation & access
- Easy maintenance
- Critical protection point in the distribution system
- Easy data collection & transmission

INSTALLATION INCLUDES

- 2 Parameter monitoring installed at key locations in the distribution
- 2 Parameter information is data-logged
- Transmission to central location
- Standard SCADA software and hardware with graphic display and alarms
- Integration with exist SCADA systems.

ONE or TWO KEY PARAMETERS

- Oxidation Reduction Potential (ORP/Redox)
- Conductivity/TDS

OXIDATION REDUCTION POTENTIAL

ORP/REDOX

OXIDATION REDUCTION POTENTIAL

- Define
- Applications
- Verification protocol
- Measurement apparatus
- Typical installations

WHAT IS OXIDATION REDUCTION POTENTIAL

Oxidation Reduction Potential is…………

A measurement of a waters capacity to oxidize and reduce

DOWN TO EARTH EXAMPLES

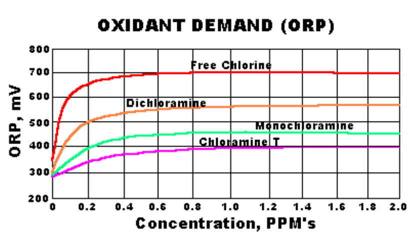
ORP TECHNOLOGY

- Meter and probe technology
- Typically not temperature compensated
- Combination ORP measurement cell and reference cell, (Much like pH electrodes)

KEY ORP POINTS

All measurements are taken on-site
All measurements in Millivolts (mV)
ORP probes not typically temperature compensated.
May take longer time window to get stabilized readings
Expect more probe maintenance than w/ typical pH probes.

ORP VERSUS CHLORINE



(US Filter/Stranco, 1998)

pH/ORP RELATIONSHIP

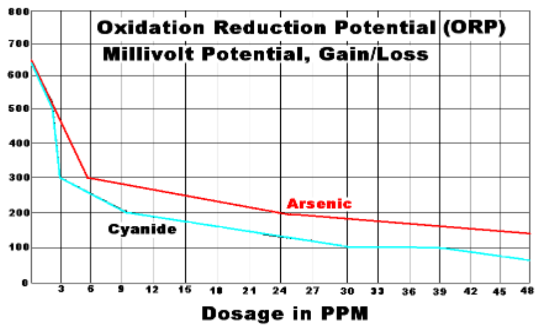
ORP VERSUS CONTROLLED CONTAMINATE DOSE STUDIES

- Investigation into how two common toxics might respond in distribution system
- Bench-top lab controlled dosing
- Chlorinated treated potable water samples
- Controlled additions of:
  - Sodium Cyanide
  - Sodium Arsenite

DISTRIBUTION WATERS BACKGROUND DATA

- pH: 8.55
- Measured Total Residual Chlorine: 0.89ppm
- Corresponding initial ORP measured: +655Mv
- Temperature: 19.8 Degrees C

ORP/DOSE RESPONSE



CONDUCTIVITY/TDS

- Total Dissolved Solids
- Anything that passes through a 0.45 micron filter
- Includes:
  - Carbonates, Bicarbonates, (ALK, Hardness)
  - Chlorides, Sulfates, Borate's, Phosphates
- Most potable waters should be < 500 PPM

CONDUCTIVITY/TDS

- Measured with meter & probe
- Multi-parameter meter
  - Conductivity - (Specific Conductance)
    - Micromhos
    - Microsemiens
  - Total Dissolved Solids
    - PPM
    - PPT

DISTRIBUTION WATER CONDUCTIVITY

- Tends to increase whenever chemical compound is added
- Common treatment chemicals
  - Alum
  - Ferric Chloride
  - Chlorine
  - Caustics
- As well as toxic substances

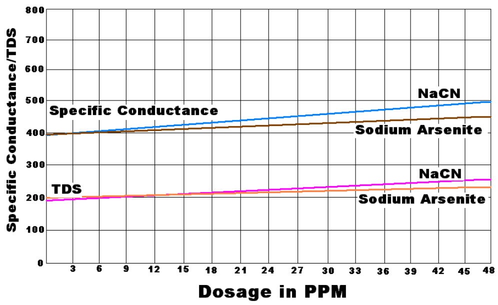
CONDUCTIVITY V/S CONTROLLED CONTAMINATE DOSE STUDIES

- Investigation into how two common toxics might respond in distribution systems
- Bench-top lab controlled dosing
- Chlorinated treated potable water samples
- Controlled additions of:
  - Sodium Cyanide
  - Sodium Arsenite

DISTRIBUTION WATER BACKGROUND DATA

- pH: 8.55
- Measured Total Residual Chlorine: 0.89ppm
- Initial Conductance/TDS: 399ms/ 197ppm
- Temperature: 13.6 Degrees C

CONTROLLED TOXIC DOSE v/s CONDUCTIVITY/TDS



IINSTRUMENTATION SELECTION

- ORP & Conductivity instrumentation selection protocol
- ORP & Conductivity Probe selection protocol
- Data-logging instrumentation protocol
- SCADA instrumentation selection and interface.

SELECTING MONITORING POINTS in the DISTRIBUTION

- Obtain updated valid distribution valve and piping maps and schematics.
- Select critical points in the distribution for monitoring
  - Large high populations activity sites
    - Stadiums
    - Large industrial users
    - Colleges/Universities
- Where large volume of general population congregate

SELECTING MONITORING POINTS in the DISTRIBUTION

- Critical junctures with large pipe diameter distribution lines.
- Probes & meter installation sites with ease of installation.
- Power source availability
- Data transmission pathway
- Protection from vandals

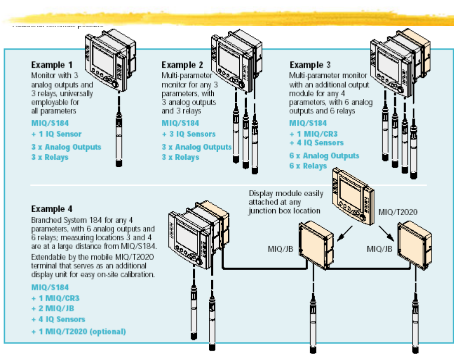
Low Cost SCADA

Low Cost SCADA

Low Cost SCADA

ORP MONITORS

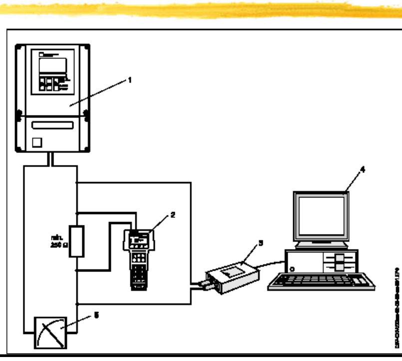
ORP MONITORS



ORP MONITORS

ORP MONITORS

ORP MONITORS



ORP MONITORS

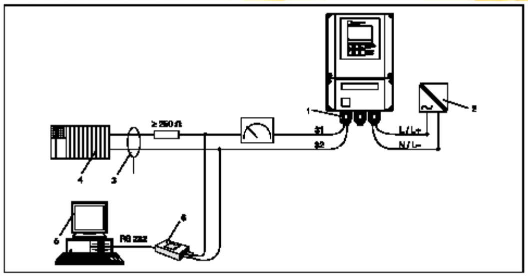


Fig. 6: Electrical connection of the Commubox FXA 191
1 = current output 1 of the transmitter, 2 = power supply, 3 = screening, 4 = other switching units or PLC with passive input, 5 = PC with operating software, 6 = HART® modem Commubox FXA 191

ORP/CONDUCTIVITY PROBE SELECTION

- Standard probe tip or flat surface
  - Glass probe
- Probe body type(ORP & Conductivity)
  - Plastic
  - Stainless Steel
- Pressure Ratings
  - Plastics - typically to 80PSI
- Double-juncture Reference element

ORP & CONDUCTIVITY PROBE SELECTION

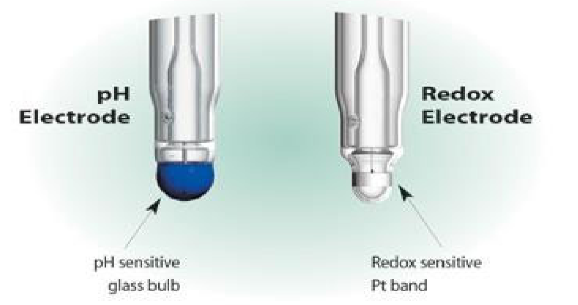
- Probe installation
  - Compression
  - insert/value isolation
  - Saddle
  - Threaded insert

Probe Insertion Hardware


WDM PipeSonde™ In-Pipe Probe

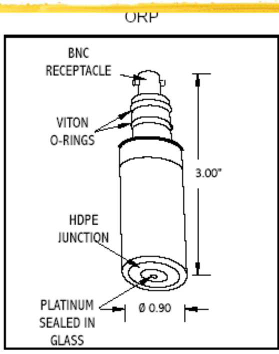
Seven Water Quality Parameters in One Probe.

ORP Versus pH Probes



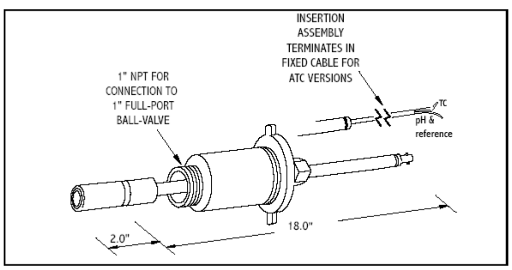
ORP PROBES CHOICES

FLAT ORP PROBE DESIGN

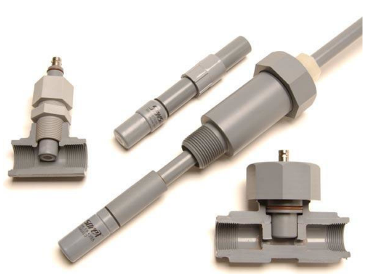


INSERT ORP PROBE ASSY.

CPVC pH and ORP Insertion Assemblies (With and Without ATC)



MORE ORP PROBE CHOICES



FLAT SURFACE ORP PROBE

VERIFYING ORP CALIBRATIONS

- Four Calibration Methods
  - Light's Solutions, (453mV @ 20° C)
  - PrePackaged Calibration Standards, (pt size)
    - 200mV
    - 400mV
    - 600mV
  - Zobel's Solution (228mV @ 20° C)
  - pH Buffer 4 & 7 saturated w/ Quinhydrone
    - Saturated Buffer 7 should read approx.+ 90mV
    - Saturated Buffer 4 should read approx. +270mV

SATURATED BUFFER CALIBRATIONS

- Prepare electrode by cleaning
  - Liquid soap & soft bristled toothbrush
- Saturate 50-100mL of each buffer w/ about 0.2g of Quinhydrone
- Connect probe to meter and immerse in each solution. Wait for table reading
- Always rinse probe between each submersion with DI or tap-water

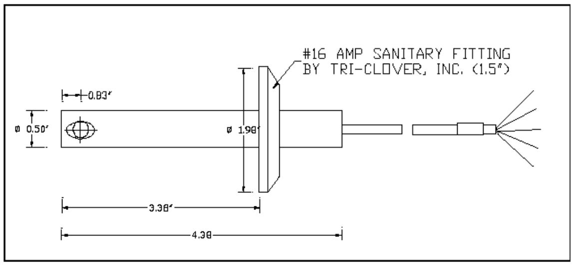
CALIBRATION INTERPRETATIONS

- Test verifies function of platinum & reference cells
- If probe responds w/ adequate difference between the 4 & 7 saturated buffers
- But..is out of calibration range
- Indicates a plugged reference cell or contaminated filling solution.
- Discard all solutions when done, no >2 hrs.

CONDUCTIVITY MONITORS

SANITARY CONDUCTIVITY PROBES

SANITARY CONDUCTIVITY PROBES



CONDUCTIVITY PROBES

CONDUCTIVITY CALIBRATIONS

- Pourable multiple component salts standards
- Supplied in uS & TDS concentration
- Use at least one standard for each range of the meter
- Pour enough to standard into separate vessel to cover bottom of probe

CONDUCTIVITY CALIBRATION PROTOCOL

- Pour only enough solution in a beaker to cover measurement element
- Calibrate as close as possible to actual sample temperature.
- Wait for meter/probe to stabilize
- Adjust meter calibration as needed
- Dispose of calibration solutions when done

CONDUCTIVITY CALIBRATION SOLUTIONS

Conclusions

- Simple probe based monitoring of distribution systems can be viable for small systems
- Low-cost ORP/Conductance measurements may give early warning to potential issues.
- Easy maintenance and operations are key to success here.
- Follow-up with verification tools will be key to make this early-warning system work