The Water Opportunity Show™
Residential • Commercial • Industrial

WQA AQUATECH USA

Drinking Water Corrosion Control and POU/POE Treatment

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WQA Aquatech USA 2013 • Indianapolis, Indiana

- Symptoms of Corrosion
- Types & Causes of Corrosion
- Lead & Copper Rule
- Regulatory Environment
- Corrosion Prevention & Remediation
- POU Devices
- Challenges & Opportunities

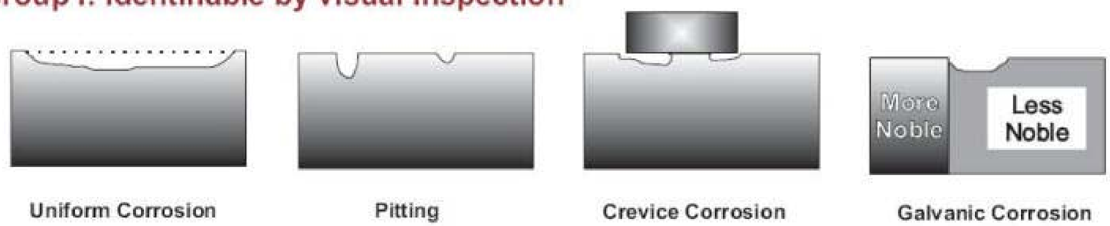
Symptoms of Corrosion

- Color in water
- Color on surfaces
- Tastes & Odors
- Sediment and Particulate
- Leaks in Tubing/Piping, Appliances or Fixtures

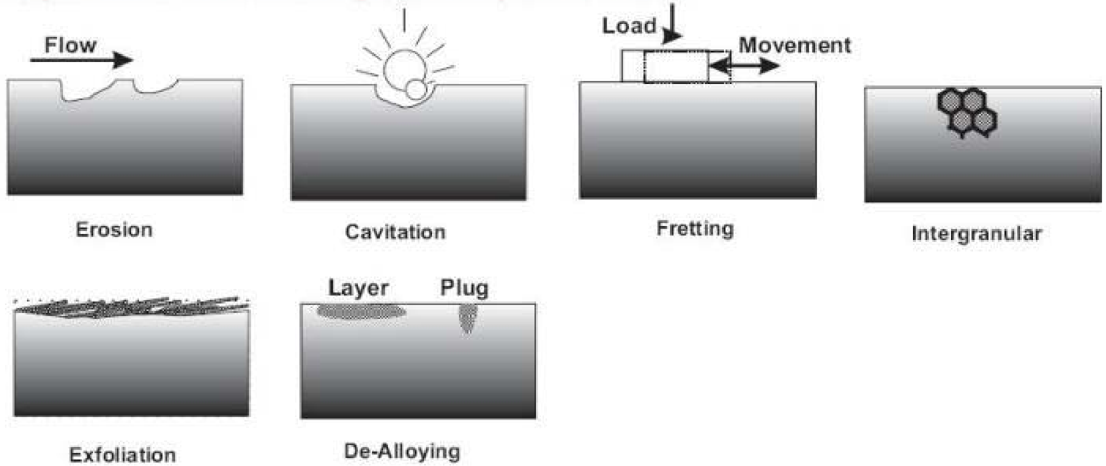

1822 20KV
10µm WD18

Types of Corrosion

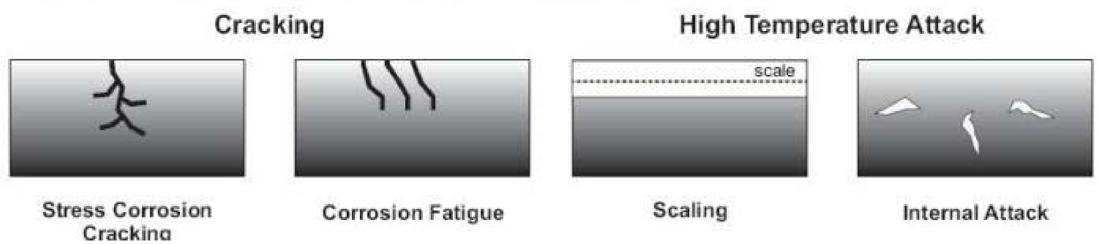
Group I: identifiable by visual inspection



Group II: identifiable with special inspection tools



Group III: identifiable by microscopic examination



Causes of Corrosion

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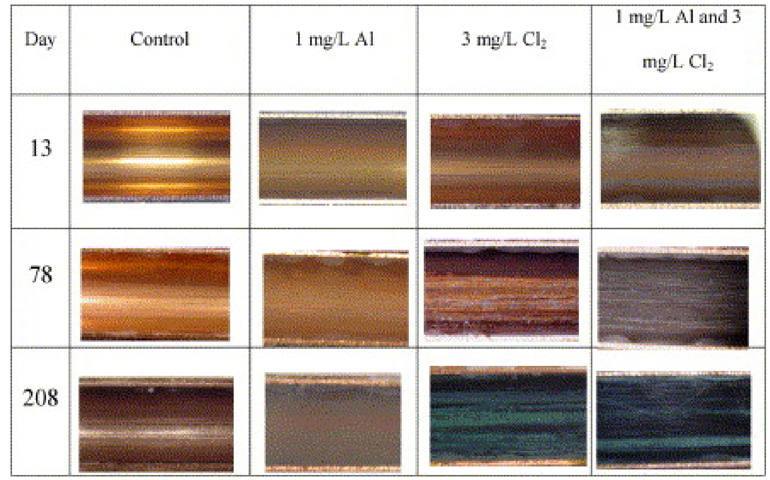
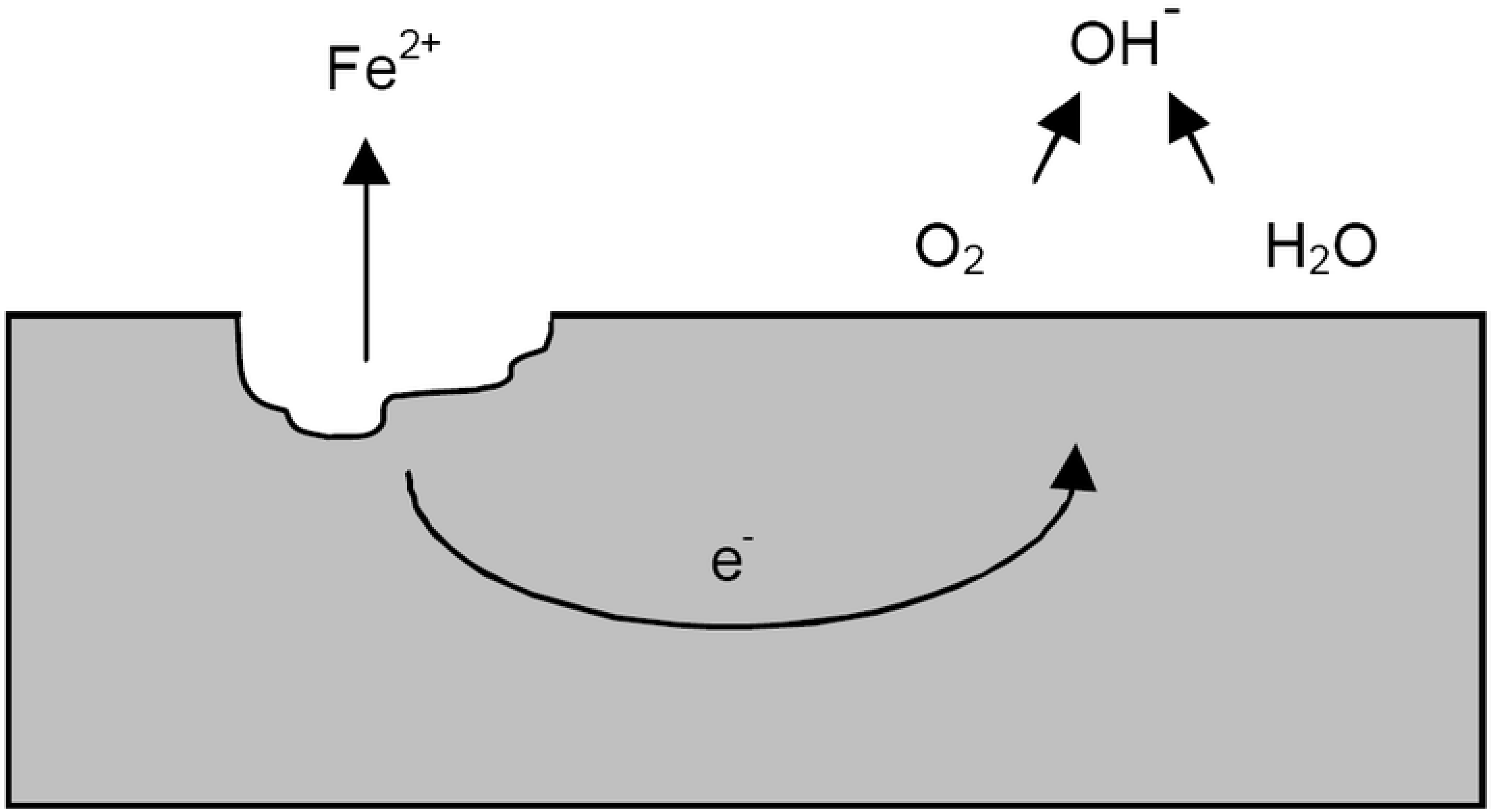
- High Velocity
- High Conductivity/TDS
- Low pH
- High Temperature
- Chlorine, Chloramines, and Chlorides
- DIC – Dissolved Inorganic Carbonates
- Dissimilar Metal contact – Direct or via electrolyte
- Biofilm Accumulation – Microbially Induced Corrosion



Electrochemical Corrosion of Iron



Oxidation = LOSS of electrons

Dissimilar Metals

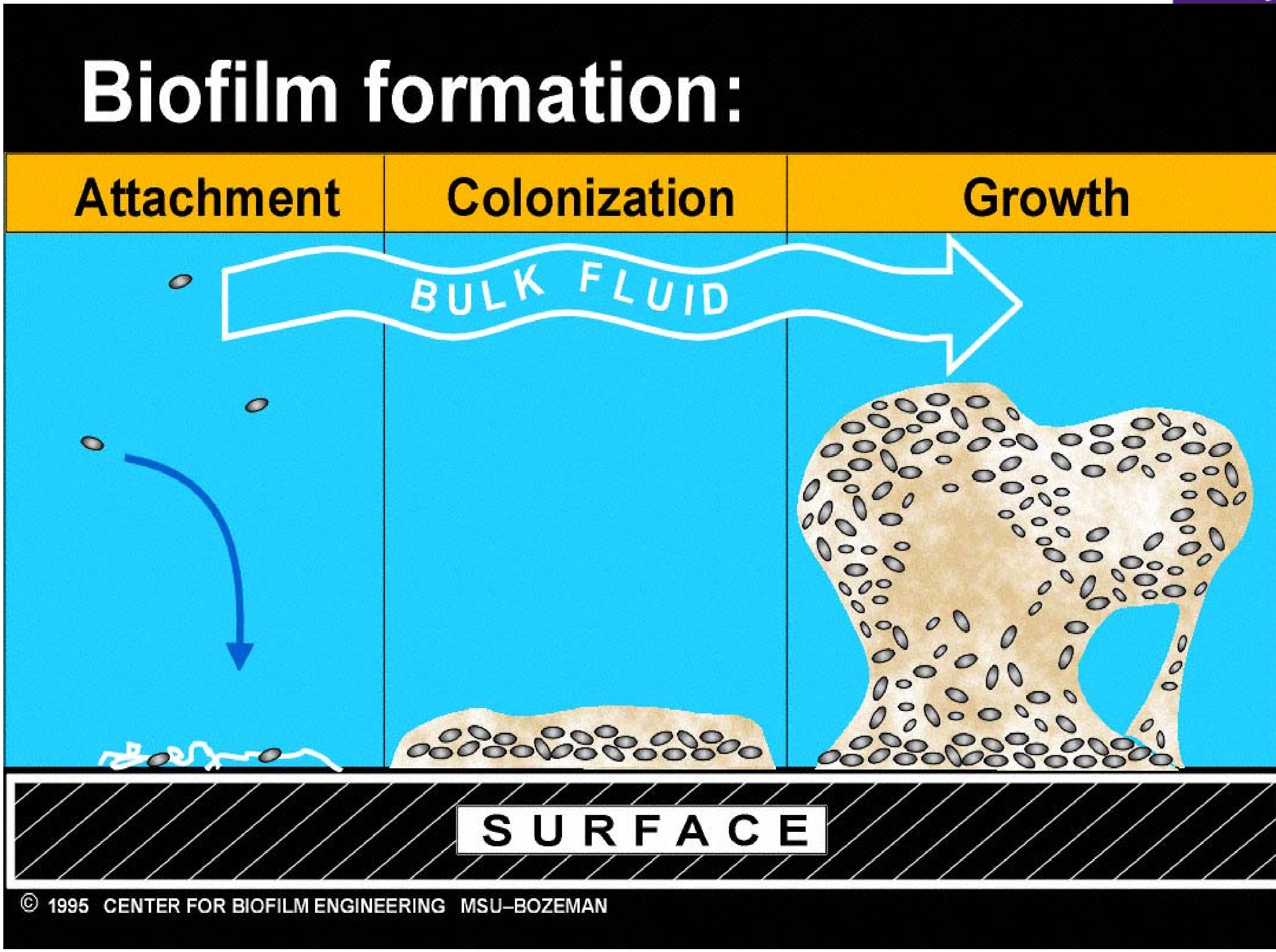
Anode (Most Active)

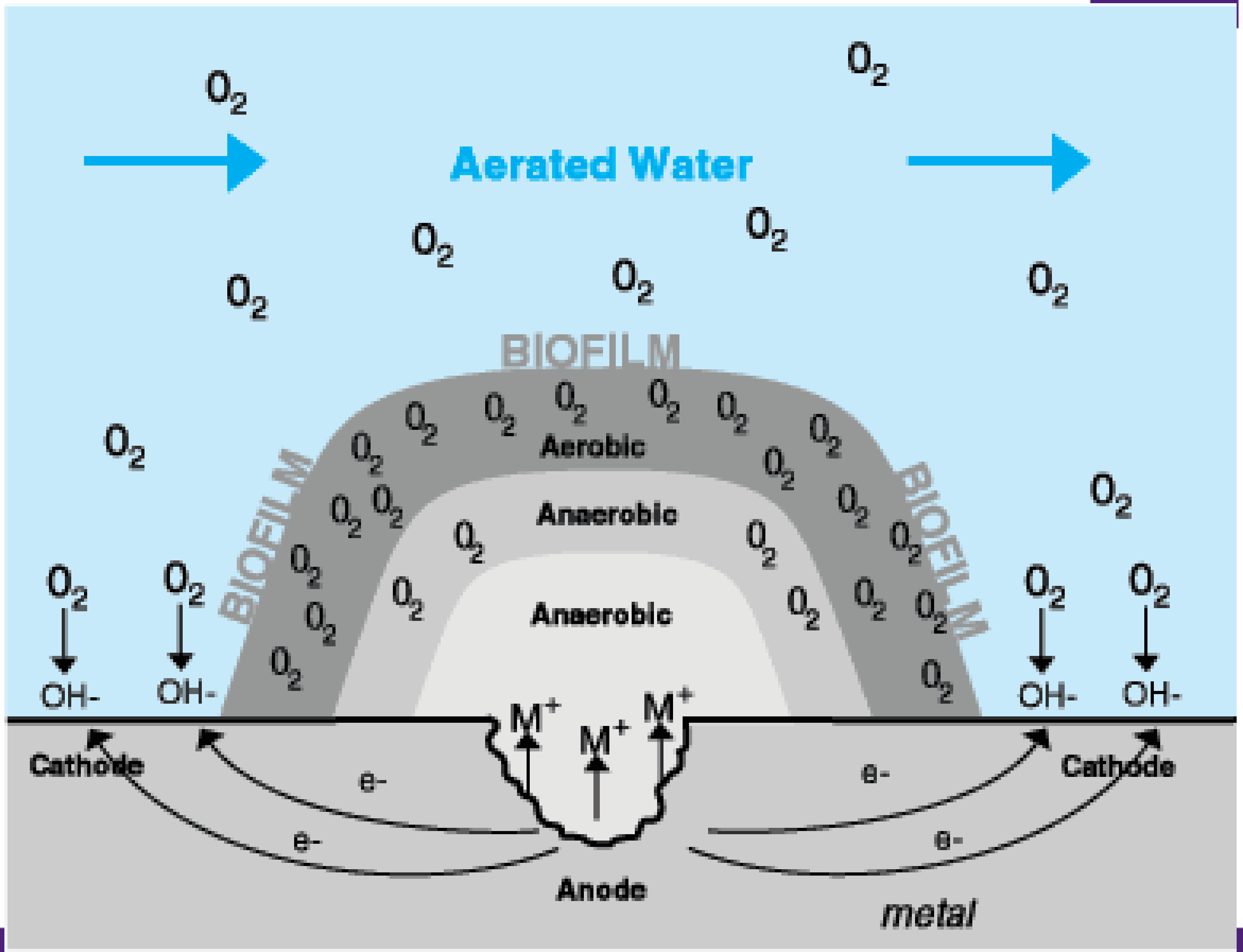
Cathode (Least Active)

Magnesium
Zinc
Aluminum (2S)
Cadmium
Aluminum (175T)
Steel or Iron
Cast Iron
Lead - Tin solder
Lead
Nickel
Brass
Copper
Bronze
Stainless Steel (304)
Monel Metal
Stainless Steel (316)
Silver
Graphite
Gold

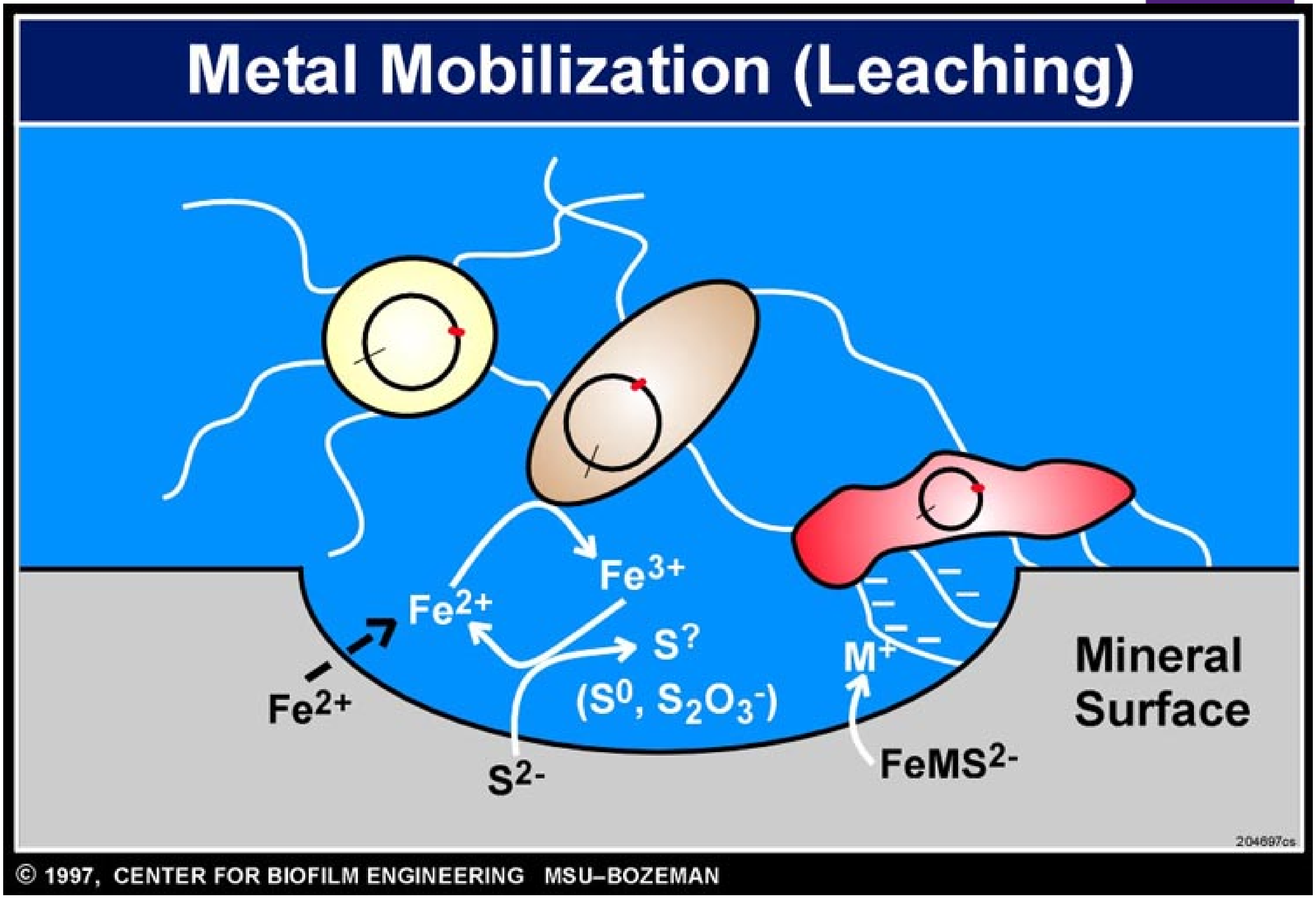
Metal	Index (V)
Gold, solid and plated, Gold-platinum alloy	0.00
Rhodium plated on silver-plated copper	0.05
Silver, solid or plated; monel metal. High nickel-copper alloys	0.15
Nickel, solid or plated, titanium an s alloys, Monel	0.30
Copper, solid or plated; low brasses or bronzes; silver solder; German silvery high copper-nickel alloys; nickel-chromium alloys	0.35
Brass and bronzes	0.40
High brasses and bronzes	0.45
18% chromium type corrosion-resistant steels	0.50
Chromium plated; tin plated; 12% chromium type corrosion-resistant steels	0.60
Tin-plate; tin-lead solder	0.65
Lead, solid or plated; high lead alloys	0.70
2000 series wrought aluminum	0.75
Iron, wrought, gray or malleable, plain carbon and low alloy steels	0.85
Aluminum, wrought alloys other than 2000 series aluminum, cast alloys of the silicon type	0.90
Aluminum, cast alloys other than silicon type, cadmium, plated and chromate	0.95
Hot-dip-zinc plate; galvanized steel	1.20
Zinc, wrought; zinc-base die-casting alloys; zinc plated	1.25
Magnesium & magnesium-base alloys, cast or wrought	1.75
Beryllium	1.85

Maintain < 0.15V Differential wherever possible


Biofilm formation:
Attachment
Colonization
Growth
BULK FLUID
SURFACE
© 1995 CENTER FOR BIOFILM ENGINEERING MSU–BOZEMAN

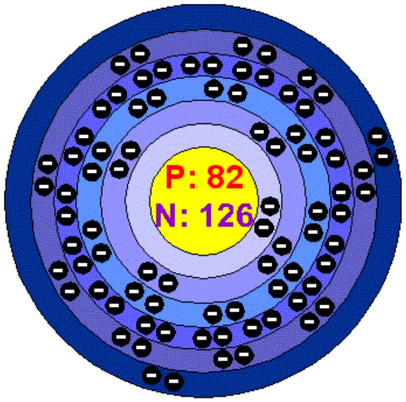


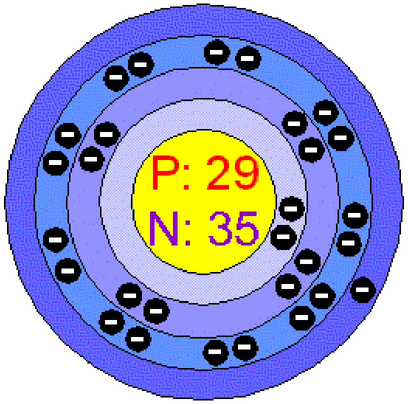
Borenstein - 1994


Metal Mobilization (Leaching)
Fe3+
Fe2+
S?
Fe2+
(S0, S2O3-)
M+
Mineral
Surface
S2-
FeMS2-
204697cs
© 1997, CENTER FOR BIOFILM ENGINEERING MSU–BOZEMAN

Health Effects of Corrosion Byproducts

Lead	Copper
Low birth weight	Stomach Distress
Retarded development	Intestinal Distress
Lower IQ	Liver Damage
Damaged hearing	Kidney Damage
Reduced attention span	Wilson's Disease Complications
Kidney Damage	
Reproductive damage	





Kayser-Fleischer ring - Wilson's Disease

Lead & Copper Rule (LCR)

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Lead and Copper Rule (LCR)2, 56 FR 26460 - 26564, June 7, 1991

"To protect public health by minimizing lead (Pb) and copper (Cu) levels in drinking water, primarily by reducing water corrosivity"

Action Level:

- **15 ppb Lead**
- **1.3 ppm Copper**

Maximum Contaminant Level Goal:

- **0 ppb Lead**
- **<1.3 ppm Copper**

Should we address causes or symptoms?

Regulatory Environment

Safe Drinking Water Act (SDWA) defines **<8% lead content** by weight as “Lead-free”

After January 4th 2014, lead free means < 0.25% by weight for wetted surfaces

Shower valves and service saddles are exempt from Public Law 111-380, California, and Louisiana laws.

Vermont and Maryland laws do not exempt service saddles.

CW617N - CuZn38Pb2
Standard Brass

CW511L - OT57 USA
Lead Free Brass

No-Lead Brass is currently 25-40 percent more expensive than leaded brass

Regulatory Environment

What is NSF/ANSI 61?

NSF/ANSI 61 is a **performance--based** standard established to measure contaminates introduced into drinking water from products. The contaminants include regulated metals including lead and copper, organics and pesticides.
For more information on NSF 61 see:
www.nsf.org/business/water_distribution/faq.asp#general

What is NSF/ANSI 61 Annex F?

NSF/ANSI 61 Annex F requirement reduces the allowable limit for lead extracted from test bodies from 15 ppb to 5 ppb (parts per billion).
The Annex F requirement has an effective date of July 1, 2012.

What are NSF 61 Annex G and NSF 372?

NSF/ANSI 61 Annex G and **NSF/ANSI 372** are **lead content** standards that can be used to verify the lead content of any product, material and component that conveys or dispenses water for human consumption.

Certified to NSF/ANSI 372

POE Corrosion Prevention Strategies

- TDS –100 – 500 TDS Range
- pH range 7.0 – 10.0
- Raise total alkalinity
- Flow - Design to minimize turbulence
- Dissimilar Metals – Separation & Isolation
- External factors – Ground paths, peripheral metallic contact
- Dissolved/Entrained Gases
- Biofilm- Maintain a sanitary system, regularly disinfect POE equipment

Corrosion Remediation Strategies

- Identify Causal Factors
- Remove Causal Factors
- Identify Damaged Areas
- Replace Damaged Areas
- Chemicals & Coatings

Protecting Drinking Water

- Adopt a layered approach
- Control causal factors
- Reduce contaminants in general for the entire building
- Provide a “final-barrier” of protection for all drinking water locations

City
- Aeration
- Soda Ash/Limestone
- Orthophosphate
- Silicates

POE
- pH Neutralizer
- Orthophosphate
- Salt-based Ion Exchange
- EDI/CDI
- RO/Nano

POU
- Reverse Osmosis
- Carbon Block for Lead
- Distillation
- Ion Exchange

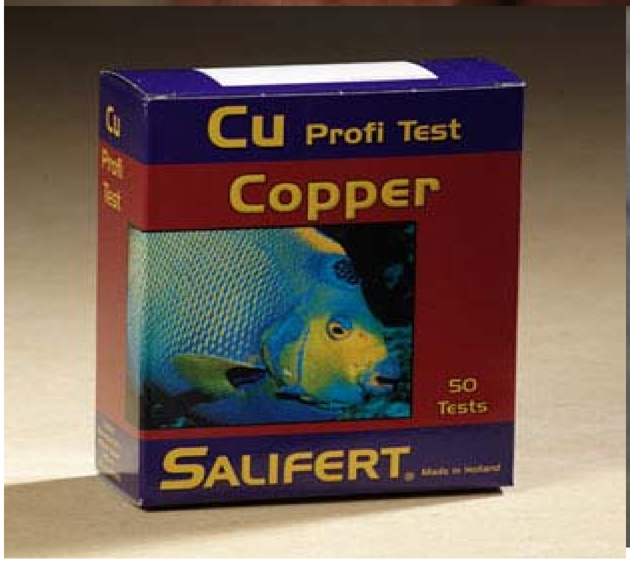

Proflow

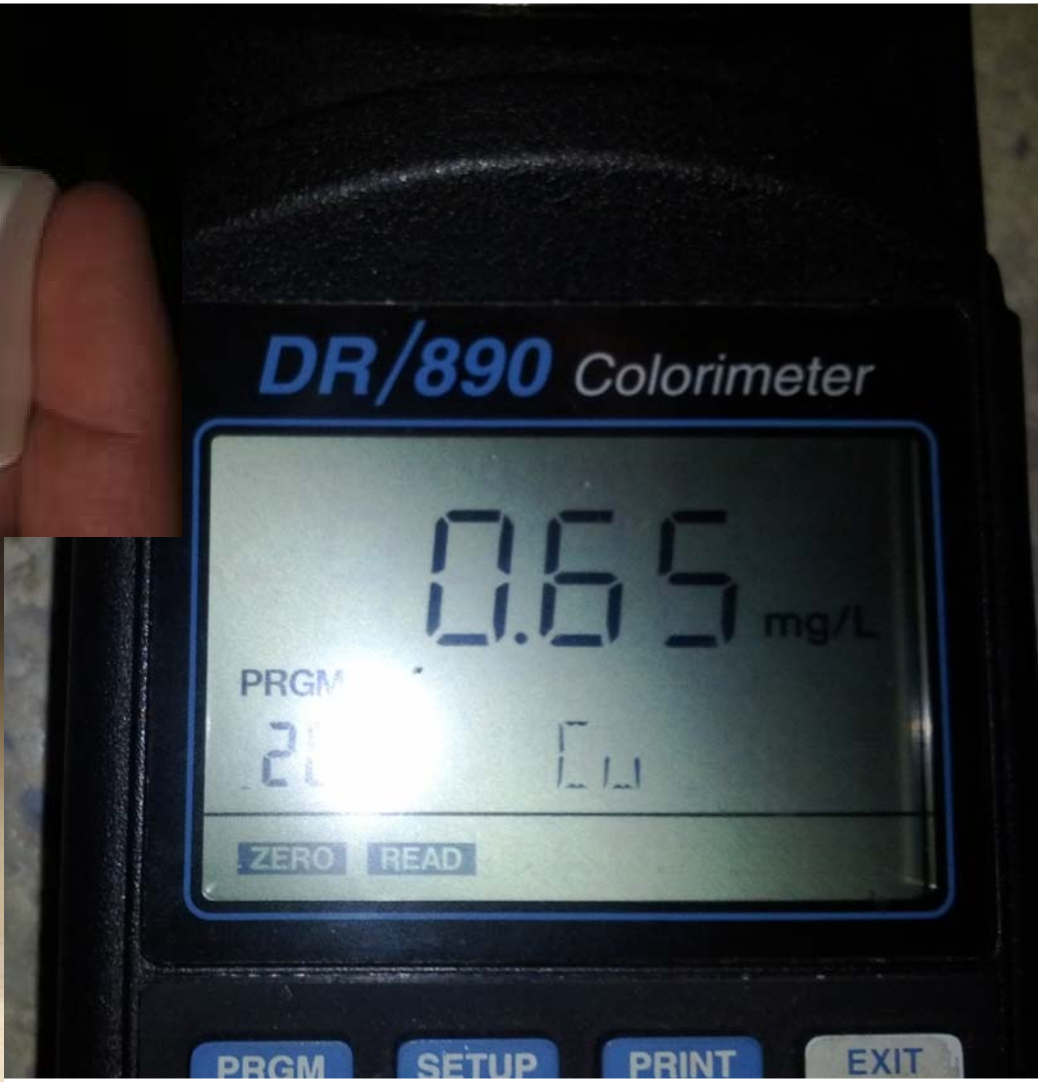
POU Treatment Technologies

Lead	Copper
Ion Exchange	Ion Exchange
Reverse Osmosis	Reverse Osmosis
Distillation	Distillation
Deionization –EDI/CDI	Deionization –EDI/CDI
Carbon Block	
Poly/Orthophosphates	Poly/Orthophosphates

Testing


Copper ppm
0 0.3 0.6 1.0 3.0


Cu Profi Test
Copper
50 Tests
SALIFERT


DR/890 Colorimeter
0.65 mg/L
PRGM
ZERO READ
PRGM SETUP PRINT EXIT

Testing

- Multiple samples per jobsite
  - Untreated
  - Treated Cold
  - Treated Hot
- Clean sample container
- Rinse with water to be sampled
- Slow sample draw – avoid aeration

✓ **Run water for at least 60 seconds at testing point for NON LCR tests**

✓ **Draw after sitting overnight for LCR test**

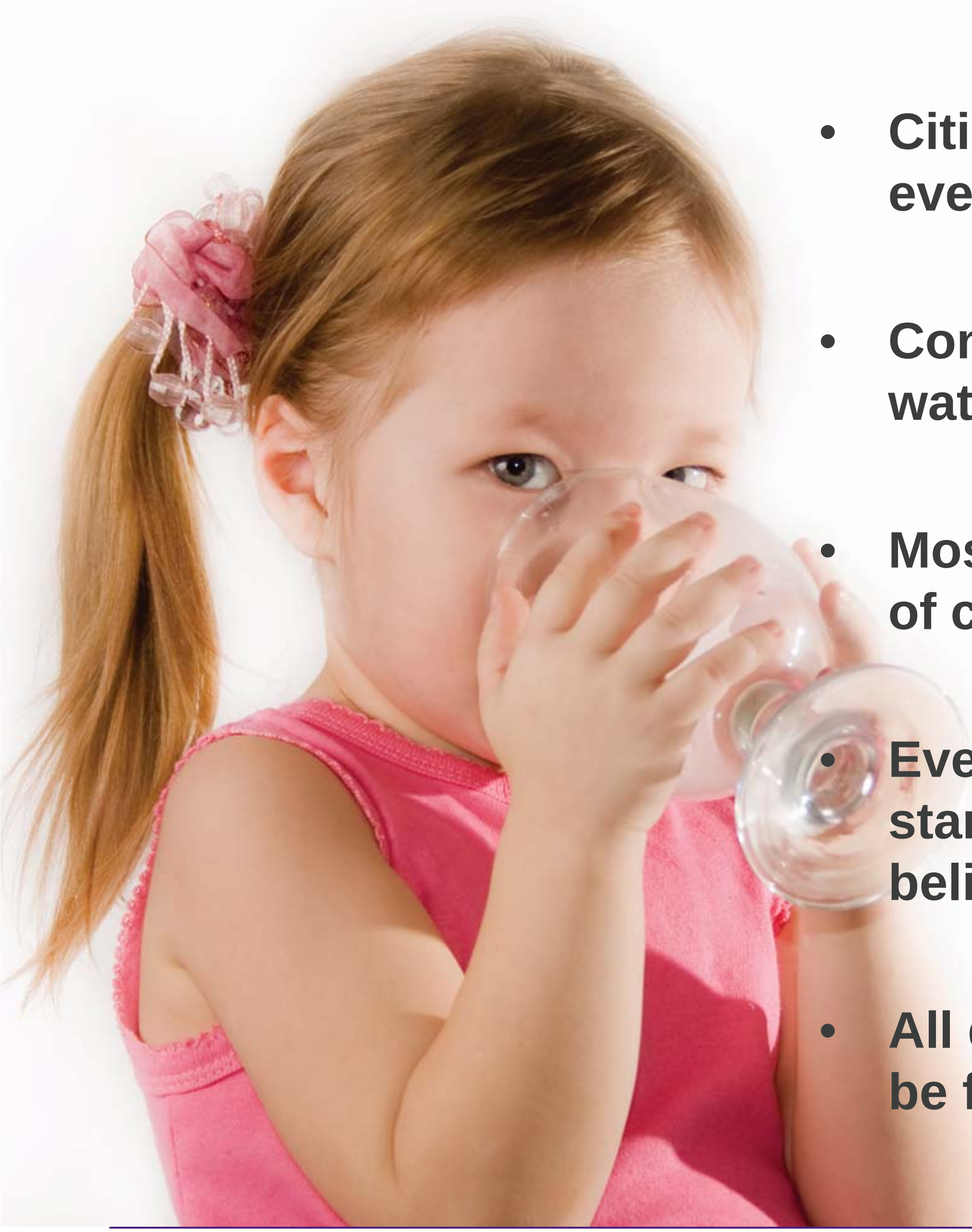
If there is even a remote suspicion that human health could be at risk or if there is legal liability, take samples to a certified laboratory

Always follow manufacturer's instructions

Challenges to Implementation

- **<u>Compounding Chemistry</u>**
  - Water that otherwise meets standards can become more corrosive after softening
- **<u>Water Softeners/Conditioners</u>**
  - Resin fouling & subsequent metal/mineral dumping
  - Regeneration malfunctions
  - Bacterial colonization
- **<u>Media Filtration Systems</u>**
  - Bacterial Colonization during regular service
  - Media Replacement frequency and sanitization
  - Chemical interactions
- **<u>General Legal Issues</u>**
  - Installation methods and materials
  - Follow-up testing

Closing Thoughts…



- Cities can't realistically protect everyone, all the time
- Consumers don't trust their drinking water to be 100% safe
- Most consumers don't like the taste of city water
- Even when water meets "minimum standards", most consumers/users believe that it isn't good enough
- All drinking or process water should be filtered