CampusEnergy
Clean Energy for the Next Generation

Effective Water Treatment

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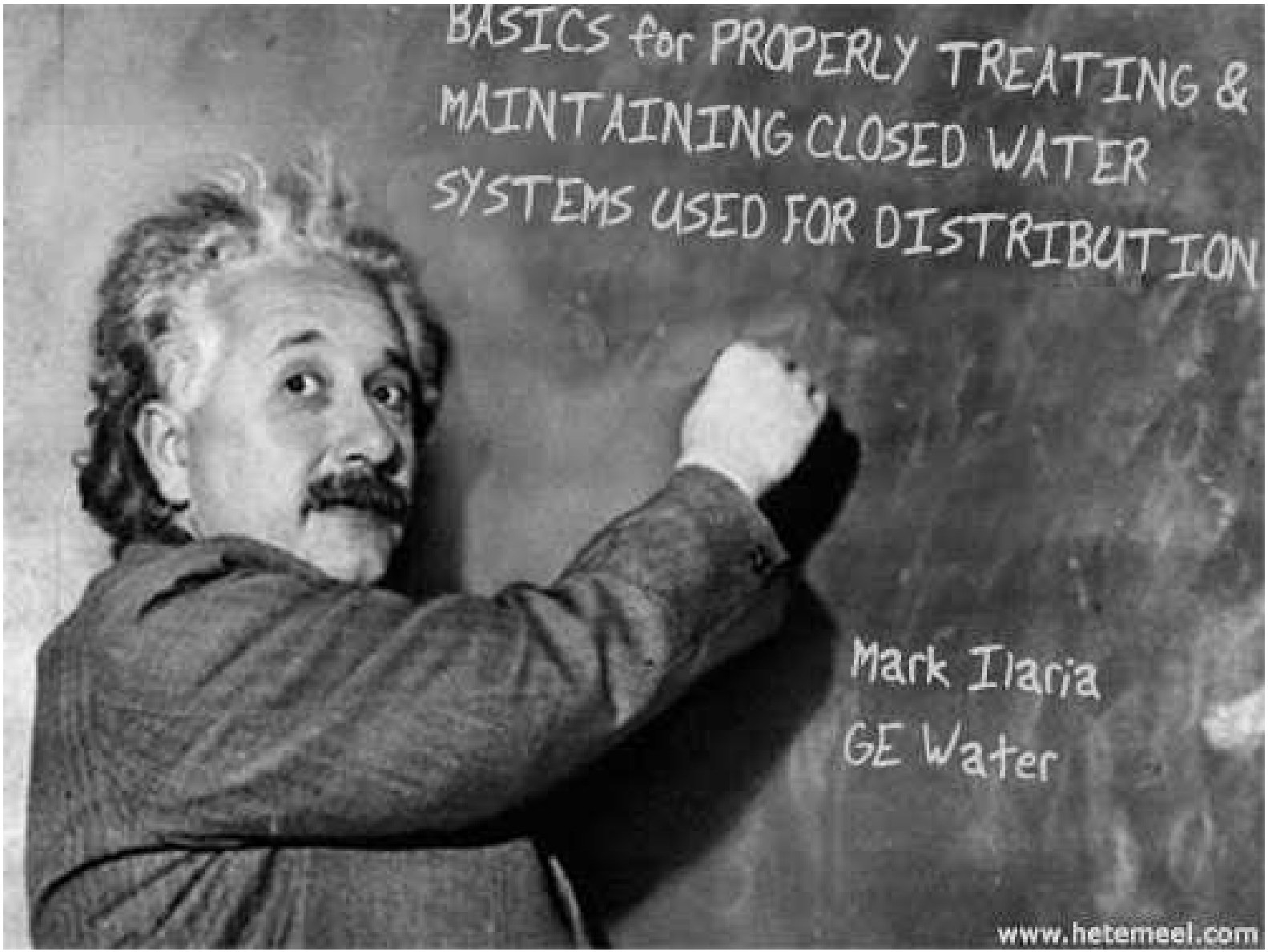
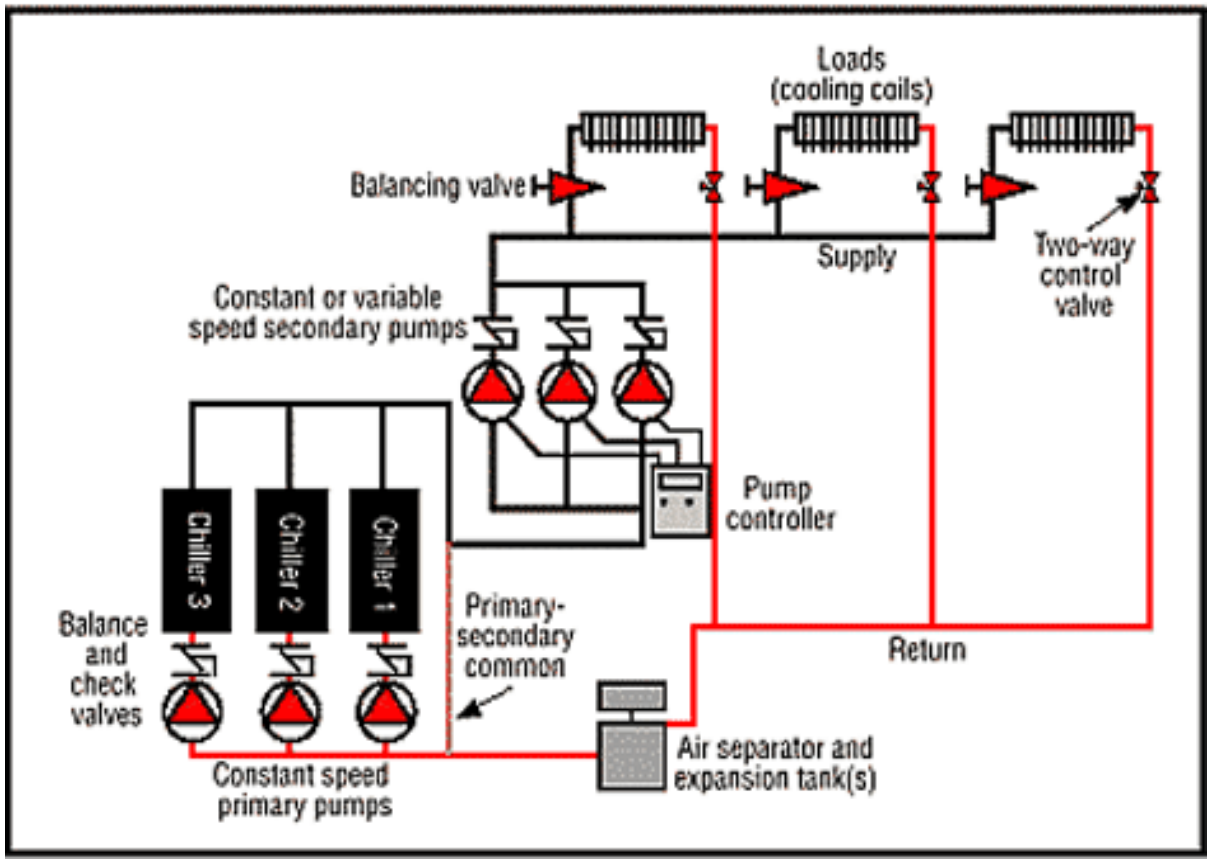
imagination at work

Closed Water System Guidelines



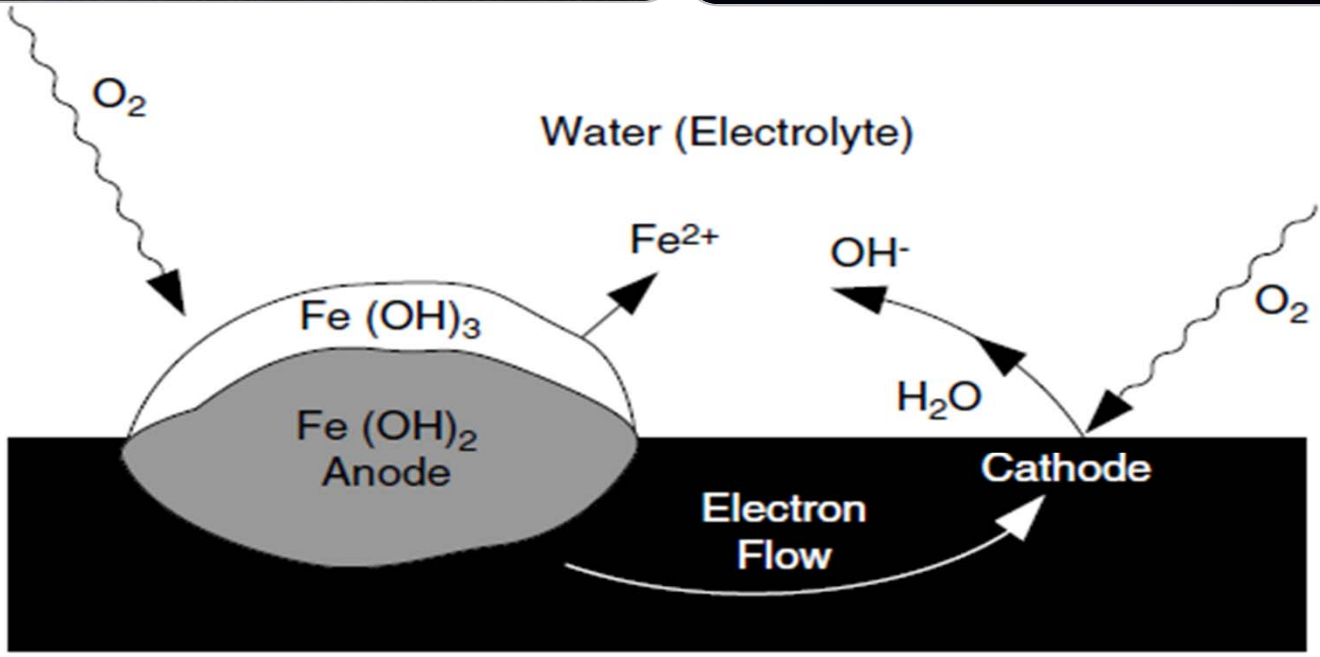
Definition of Closed Water System

- Not Open to Atmosphere
- No Water Evaporation
- Designed for Minimal (less than 1%) water losses
- Used to transport Chilled or Heating Hot Water or both with two pipe systems
- Typically treated with higher dosage levels of chemical treatment



Still subject to corrosion and scale despite being "closed"

Corrosion Cell Reaction



ANODE REACTIONS

Chemical Oxidation

$Fe^0 \rightarrow Fe^{++} + 2e$

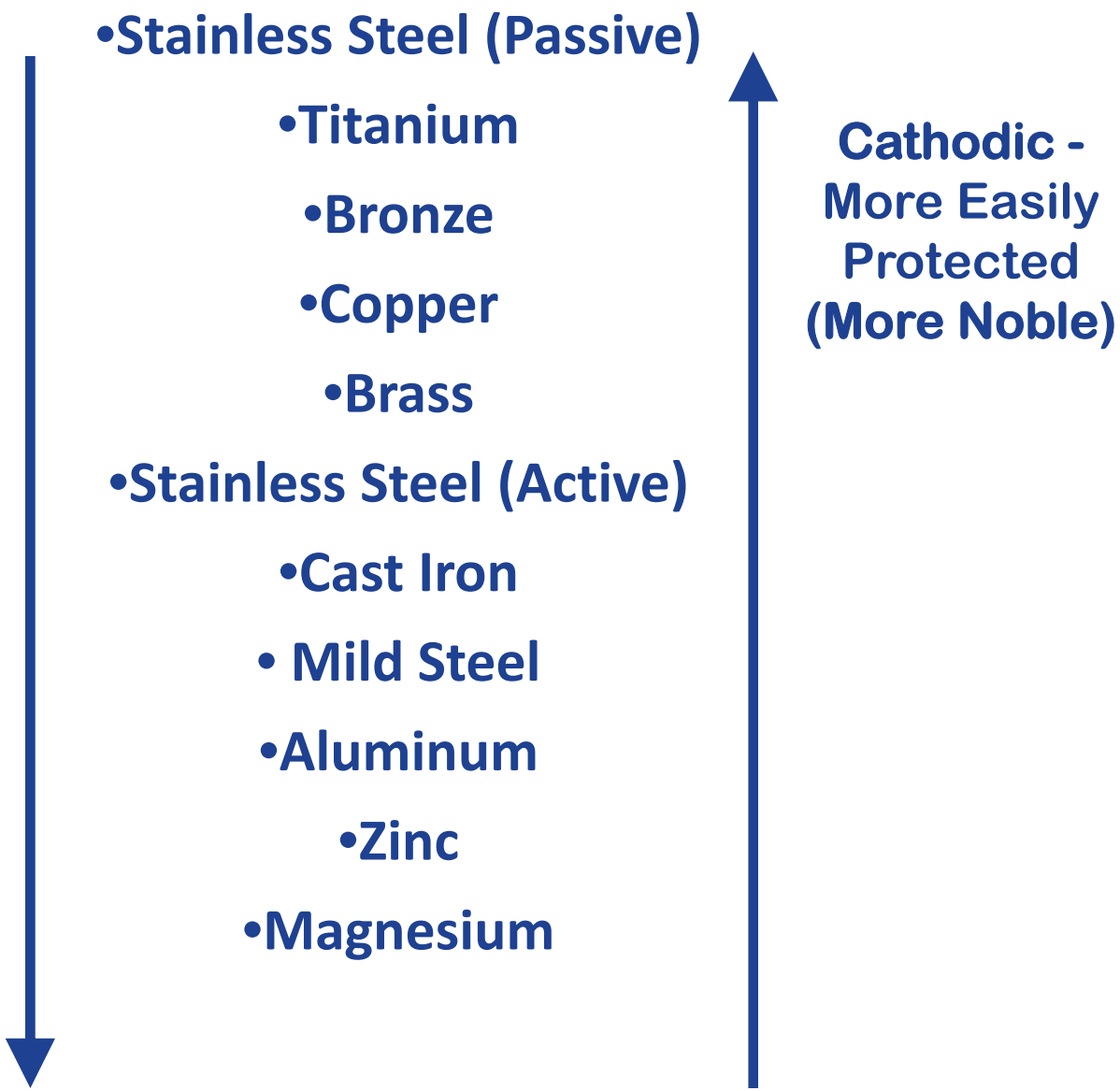
$2Fe(OH)_2 + {}^1/_2O_2 + H_2O \rightarrow 2Fe(OH)_3$

CATHODIC REACTIONS

Chemical Reduction

${}^1/_2O_2 + H_2O + 2e \rightarrow 2OH^-$

Galvanic Corrosion Basics

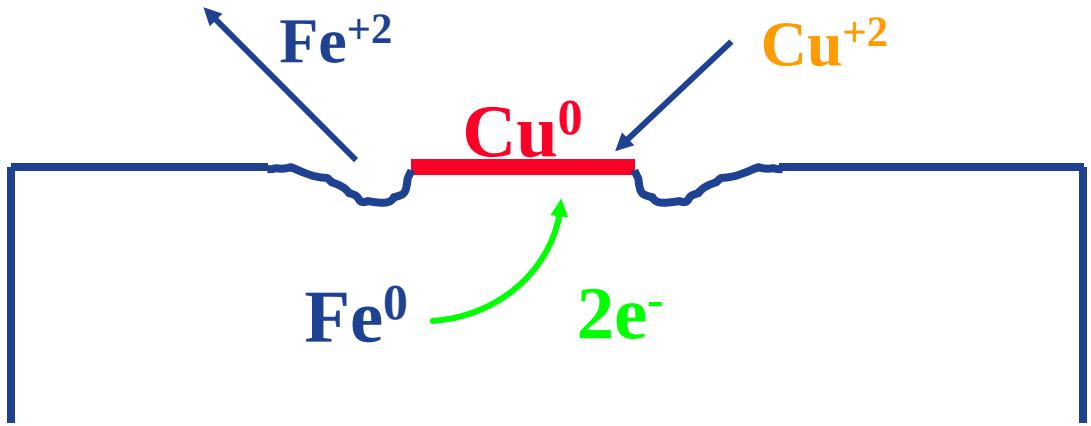


Galvanic Corrosion
(COPPER INDUCED)

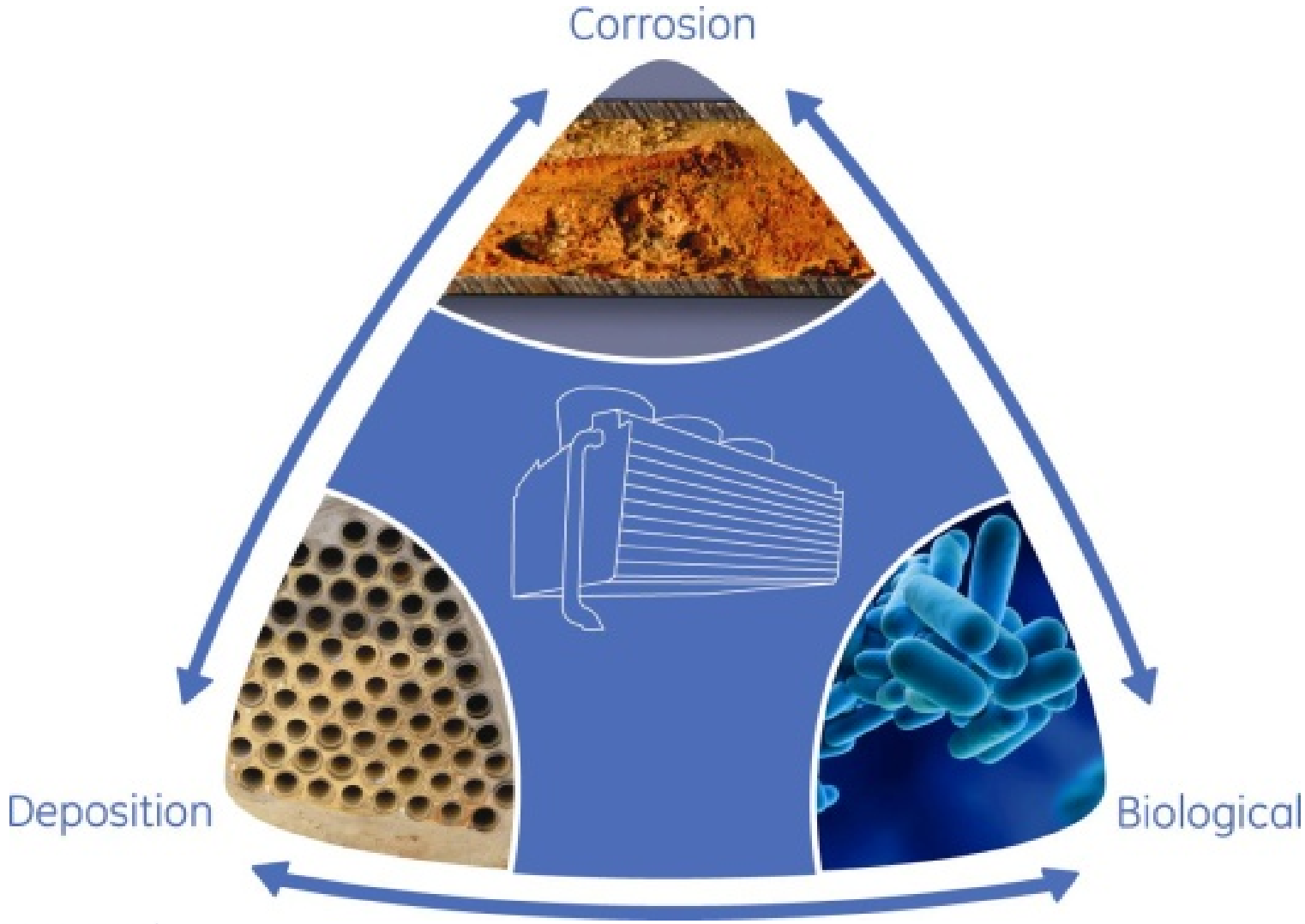
Galvanic Corrosion

Example - Copper Plating on Steel

$$Fe^{O} + Cu^{+2} \text{ ----> } Fe^{+2} + Cu^{O}$$

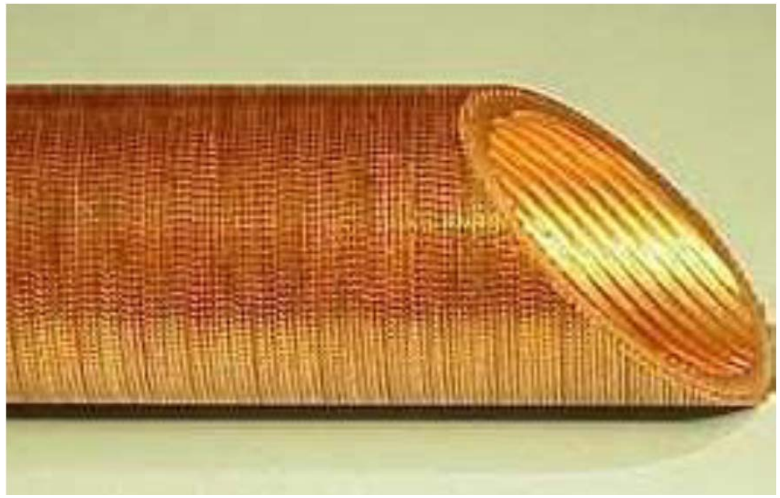


The Water Treatment Triangle



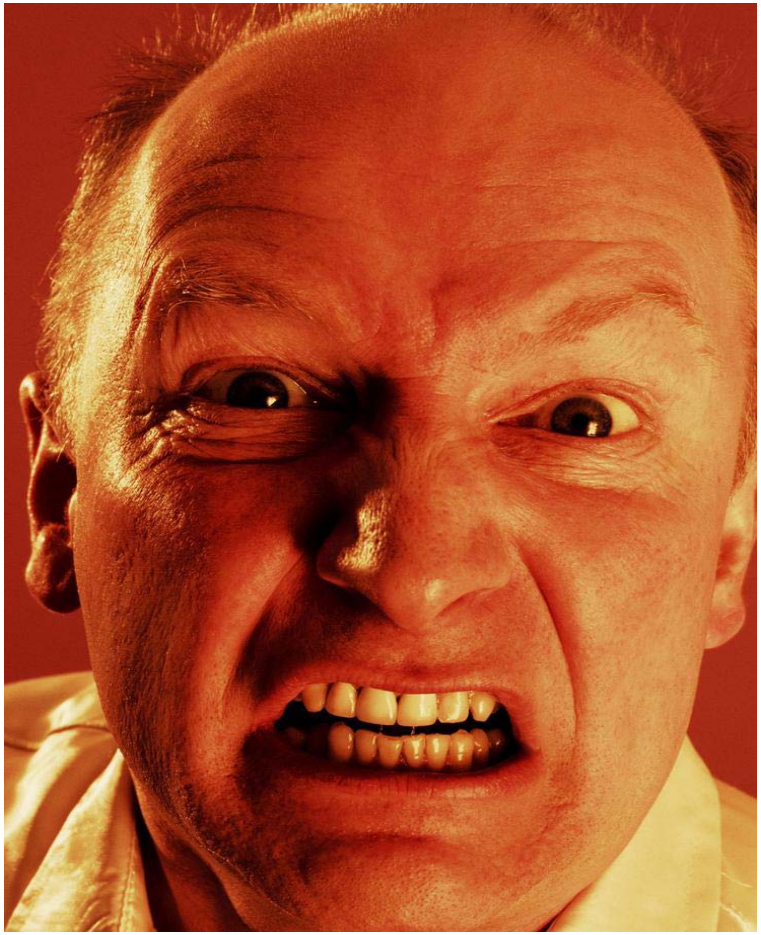
Evaporator (Chilled) Tube Design

- Enhanced on both sides
- Thinner wall thickness..
- delivers higher efficiency



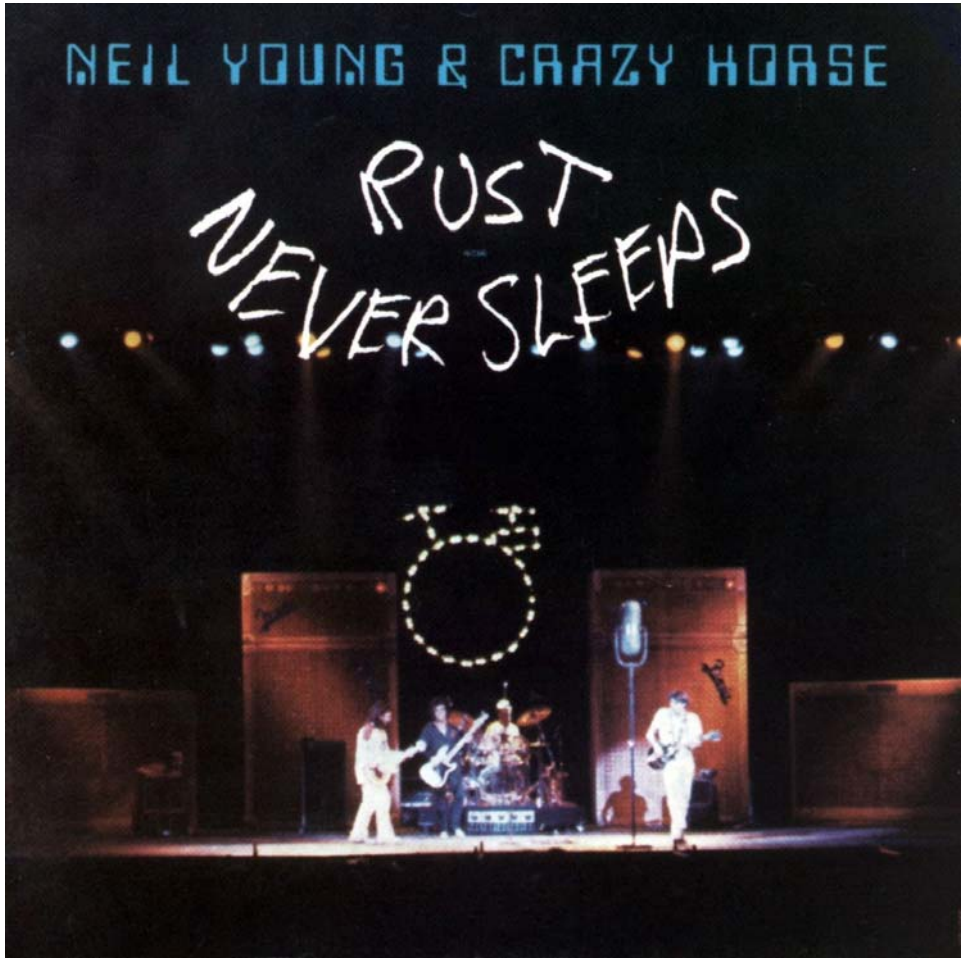
- ***Once Corrosion/Scale/Deposition Starts……..***
- Insulation Effect – Scale, Fouling, Bio
- More energy to lower water temp
    - Efficiency loss **as high as 40%**

So Now What Do We Do?



The Solution

- Mechanical
- Chemical
- Operational
- Pre-Operational
- Lay-Up



The Mechanical Solution

Proper Air Removal

Proper Water Velocity

Seal/Valve Operation

Filtration

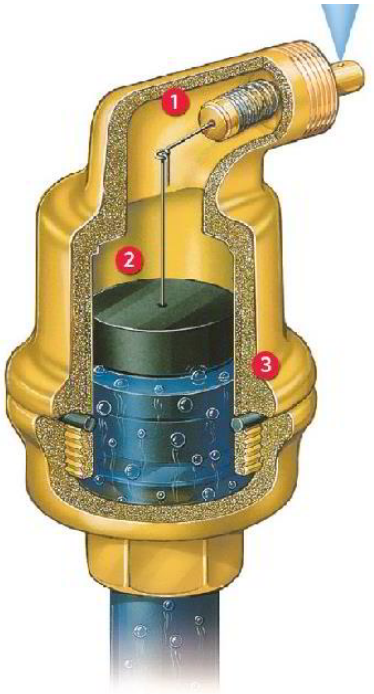
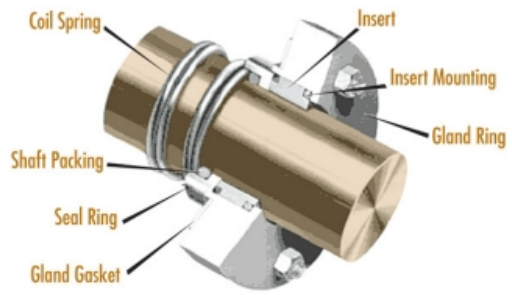


Figure 1: Single Typical Mechanical Shaft Seal



Filtration of Closed Systems

Routine Filtration for Closed Systems

Large systems system turnover of 2 to 4 days

Variable speed pumps -

Reduce velocity

Increase the tendency for deposition of debris

Greatest Impact: **Enhanced Tubes**

The Chemical Solution

Select program based on water chemistry and application

Create/Maintain Passive Barrier

Special attention to copper inhibitor and monitoring

Regular Water Testing and Monitoring

The Chemical Solution

Program based on water chemistry & application

Inhibitor	Pro's	Cons
Molybdate	Effective with no breakdown	High Cost, Heavy Metal
Nitrite	Cost effective Works rapidly	Breakdown, bacterial food
Phosphate	Low Cost	Effectiveness, Precipitation
Silica	Perceived as safe	Effectiveness, scale formation
Complex phosphate	Iron and scale removal	Breakdown, bacterial food

Scale Inhibition

Solution as part of the chemical program

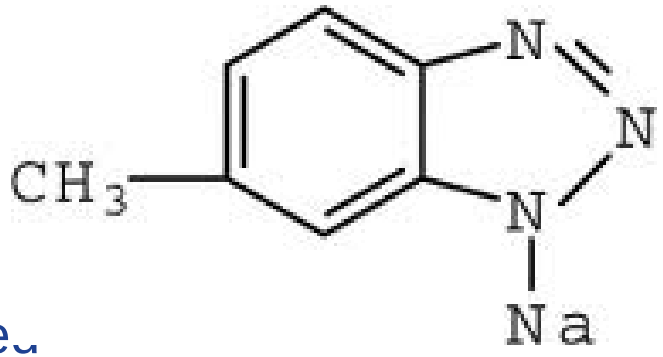
Ensure treatment formulation includes scale control agents

Monitor system chemistry closely

In hard water areas soften the fill/makeup water

If softened water used, review treatment chemistry

Copper Protection



Most used - azoles:

- Tolyltriazine (TTA) – most commonly used
- Benzotriazole (BZT) – commonly used
- Halogen Resistant Azole – unique properties

Increasing levels - sulphate and chlorides

Chemically bonds with copper and copper alloys to create film, stable for 5 - 7 days

Complex with Cu^{+2} preventing plating subsequent aggressive pitting

Closed Water Monitoring

Check inhibitor levels, conductivity & pH once/month

- Compare with make-up vs. inventory

Chilled Microbiological analysis monthly

Check for Chilled SRB bacteria quarterly

Inspect coupons quarterly, analyze

(Corrosion, Deposition, MB fouling)

- 0.1 mpy copper corrosion rate - ***critical systems***
- Up to 2 mpy steel **("hard cap")** for less critical systems

Corrosion Monitoring

Corrosion Coupon Assembly

Corrosion coupon monitoring is an in-expensive method

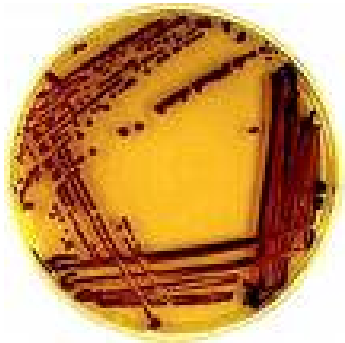
Closed system should be equipped with system metallurgy coupon sites

Biological Monitoring

ATP

Dip slides

Aerobic Count Plates (Petri Dish)



Operational

Regular movement of water on systems that are idle – *Maintain Passive Film*

Monitoring/Minimizing system losses – *Maintain chemistry and minimize oxygen re-intrusion into system*

System Layup – *Special Actions taken during idle periods, typically over one month*

Closed System Pre-Op Cleaning

Cleaning and Passivation of new piping surfaces

Proper water treatment is **essential** for

Removing oils/slag from manufacturing and construction

Protecting new pipe and creating a protective passive layer.

The precautions taken on Pre –Op cleaning

Will **add years** to Heat Exchanger/Chiller life

Closed System Lay-up

Cleanliness of the heat transfer surfaces

Proper water treatment is **essential** for

maintaining top efficiency

minimizing corrosion.

The precautions taken on laying up

Will **add years** to Heat Exchanger/Chiller life

Prevent undesirable shutdowns

Questions?

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