Boiler Water Chemical Treatment

NALCO
An Ecolab Company

Prudential Overall Supply™

Agenda

- Nalco Introduction
- General Water Chemistry Overview
- Boiler Internal Training
- Quick checks for Plant Visit
- Plant Visit Update
- Questions?

BOILER WATER TREATMENT

GENERAL WATER CHEMISTRY

Why Use Water for Heating?

Why Use Water for Heating?

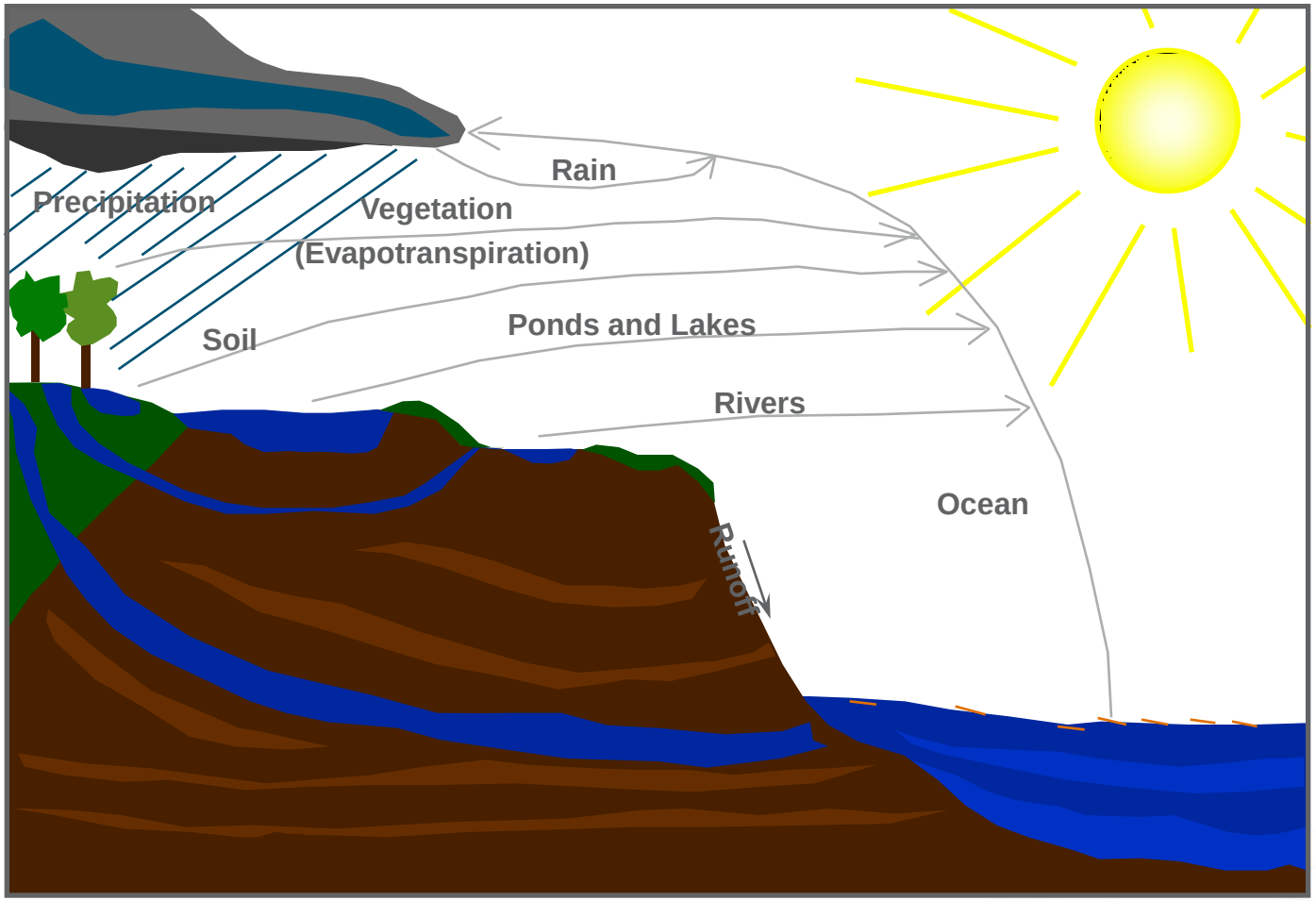
- Abundant
- Available
- Inexpensive
- Safe
- High Specific Heat

Why Isn't Water Perfect for Heating?

Why Isn’t Water Perfect for Heating?

- Dissolved Solids
- Dissolved Gases
- Suspended Matter

THE HYDROLOGIC CYCLE



Heating Water Systems
Overview

SURFACE WATER

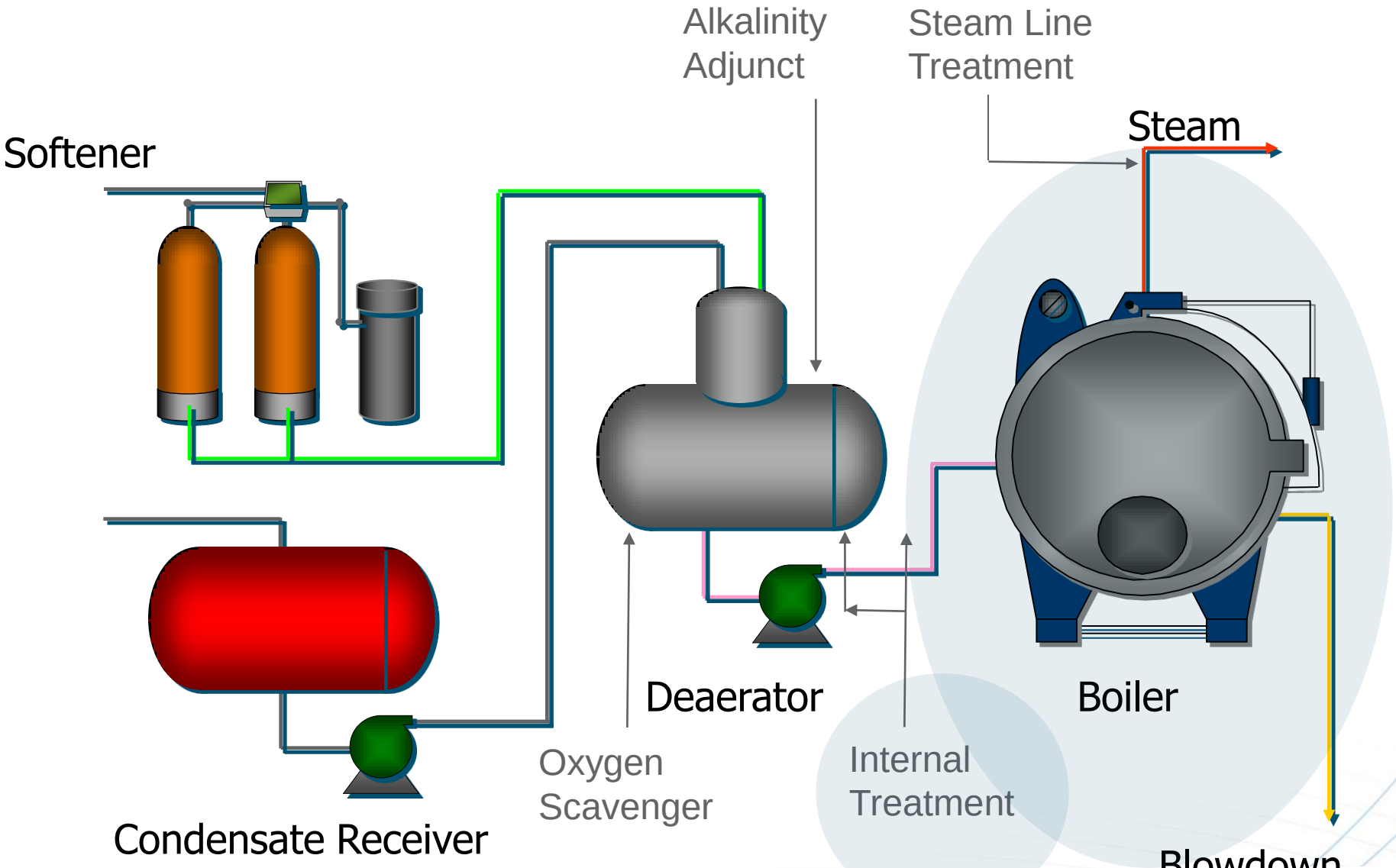
- Lower in dissolved solids
- Higher in suspended solids
- Quality changes quickly with seasons and weather

GROUND WATER

- Higher in dissolved solids and Lower in suspended solids
- Higher in iron and manganese
- Low in oxygen, may contain sulfide gas
- Relatively constant quality and temperature

BOILER INTERNAL TREATMENT

Boiler Treatment



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Purpose of Internal Treatment

- Inhibit formation of mineral scales
- Inhibit deposition of iron particles
- Maintain efficient heat transfer
- Maintain equipment integrity
- Maintain steam generation capability
- Lengthen time between or eliminate boiler cleanings

Our goal is a 100% reliable and safe source of steam

How Do We Prevent This?

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What control parameters should we be concerned with?

- Neutralized Conductivity
- "O" Alkalinity
- Sulfite residual
- Silica (If you have high Silica Make-Up)
- Hardness
- Internal Treatment Residuals

Neutralized Conductivity

- Elevated TDS
  - Boiler carryover
  - Hardness or Silica Scaling due to higher mineral content, this also can lead to elevated Stack Temps
  - Potential Deposition of iron and other foulants

- Depressed TDS
  - Increased chemical usage
  - Increased water usage
  - Increased corrosion potential in the boiler due to lower alkalinity/pH due to low cycles

Sulfite

- High Sulfite
  - Wasted product due to overfeed
  - Potential elevated corrosion rates in feedwater tank due to suppressed pH (Catalyzed Sulfite)

- Low Sulfite
  - Increased corrosion potential due to presence of oxygen in FW due to low sulfite levels
  - During offline “stand-by” operation lower sulfite levels can also lead to increased oxygen corrosion potential in internal boiler

Hardness

- High Hardness
  - Internal boiler scaling from high hardness
  - Scaling reduces boiler heat transfer efficiency (excessive fuel usage)
  - Scale leads to uneven heating of heat transfer surfaces and premature boiler tube failures

What Causes Problems with Internal Treatment?

- Mechanical Carryover
- Hardness Intrusion in Feedwater
- TDS induced Carryover

What causes Mechanical Carryover?

- Malfunctioning steam separation equipment
- Improper Level Control
- Wide load fluctuations

What are other causes of Carryover?

- High TDS in Boiler
  - This can lead to severe scaling potential or deposition of incoming minerals such as Silica, Calcium, Magnesium, and iron.

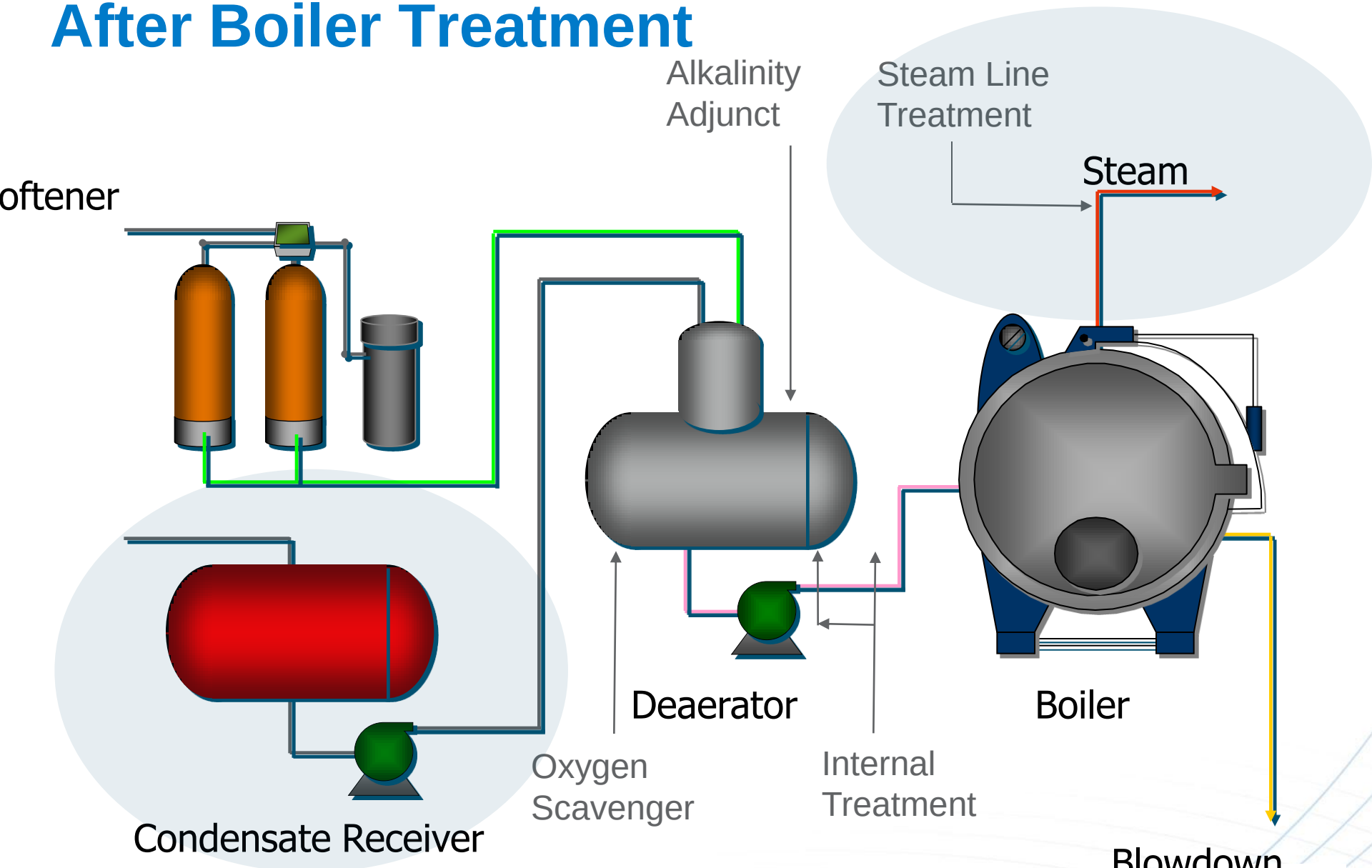
- Elevated chemical levels can lead to carryover and foaming

http://www.youtube.com/watch?v=a0xZPl_bwHI

http://www.youtube.com/watch?v=tI3tWuSsX7c&feature=relmfu

CONDENSATE SYSTEM OPERATION AND TROUBLESHOOTING

After Boiler Treatment



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Value/Benefit of Condensate

- Increased condensate return means increased thermal efficiency.
- Increased condensate return means higher boiler cycles.
- Increased condensate return means lower chemical usage.
- Increased condensate return, and better treatment, means longer equipment life.

Why Treat Condensate Systems?

"A typical 100 psi boiler system producing 8,000 pounds steam/hour may save up to $10,000/year in energy, water, and chemicals by increasing their condensate return 10%."

How Do We Prevent This?

What Causes Problems in the Condensate System?

- Carbon Dioxide
- Oxygen
- Ammonia

Where Does Carbon Dioxide Come From?

- **Breakdown of feedwater alkalinity**

$$2\,HCO_3^- = CO_3^= + H_2O + CO_2$$

Bicarbonate Carbonate Water Carbon Dioxide

$$CO_3^= + H_2O = 2OH^- + CO_2$$

Carbonate Water Hydroxide Carbon Dioxide

- **Air in-leakage**
- **Organics breakdown**

What's the Problem?

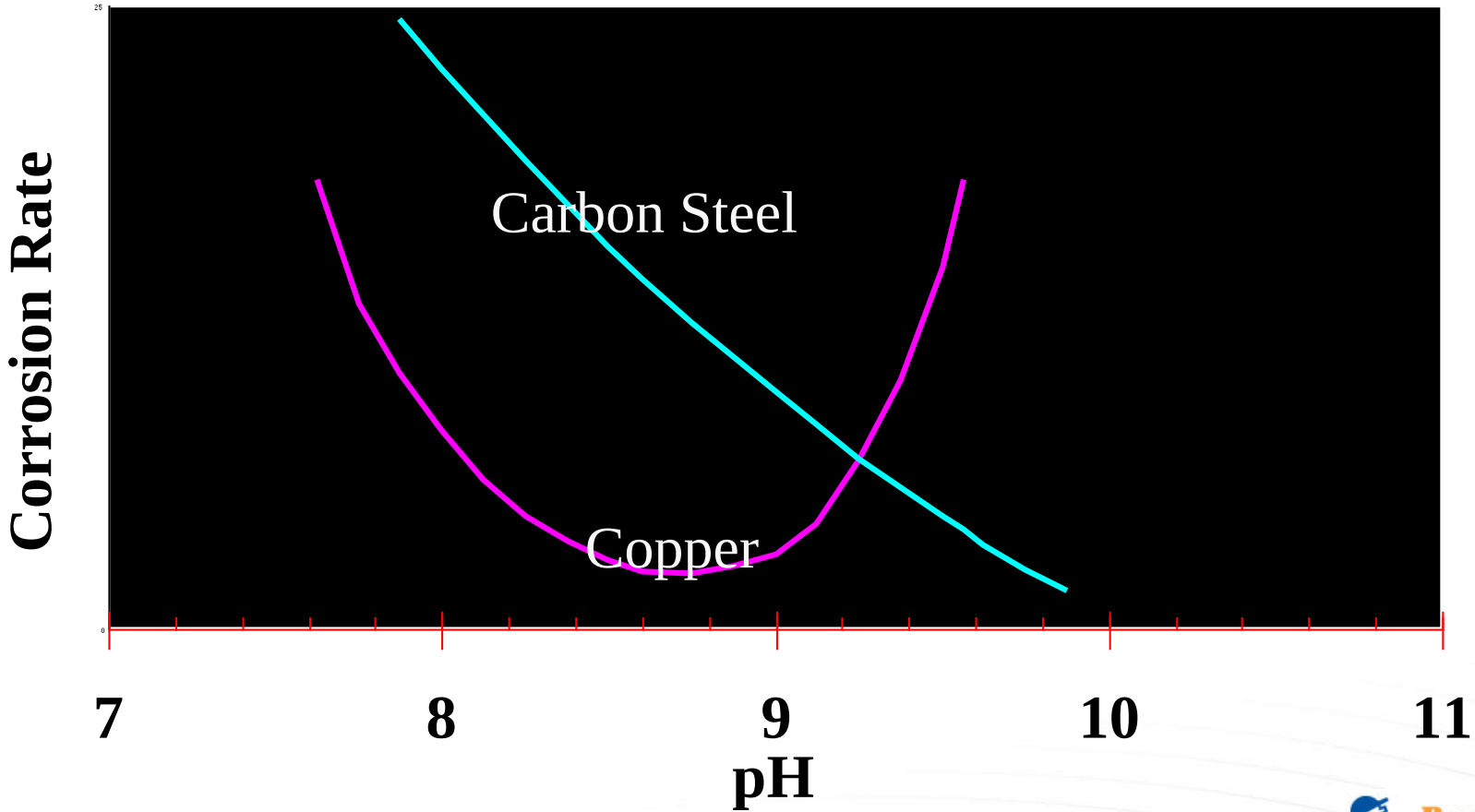
- Dissolves in the condensate forming carbonic acid

$$CO_2 + H_2O = H_2CO_3$$

Carbon Dioxide Water Carbonic Acid

- This drops the pH in the condensate and increases corrosion rates.

Corrosion of Carbon Steel and Copper Depends on pH of Water



Carbonic Acid Corrosion

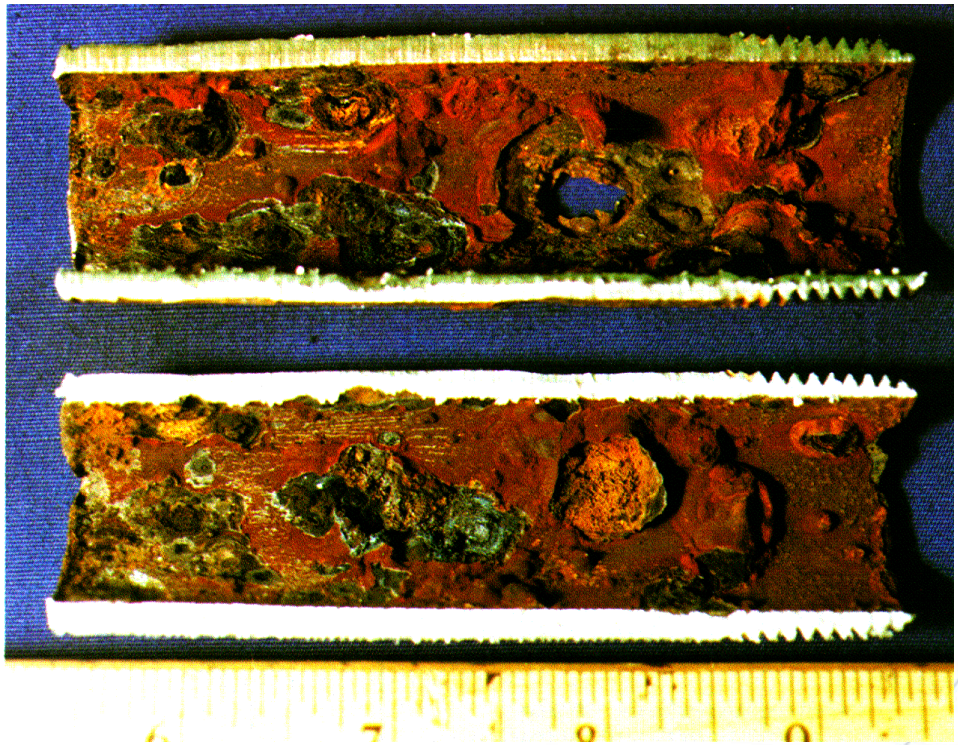
Results in a thinning and grooving of the metal surface

Where Does Oxygen Come From?

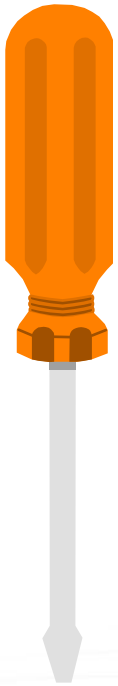
- Air in-leakage- *pumps, traps, vacuum systems, vented receivers*
- Inefficient deaerator operation
- Improper sulfite residual from FW tank to Boiler
- Raw water intrusion- *pump seals, heat exchanger leaks*

What's the Problem?

- O_2 attack results in pitting type corrosion
- Rapid localized metal loss
- Combined corrosion rate of carbon dioxide and oxygen is 10 to 40% faster than the sum of either alone...

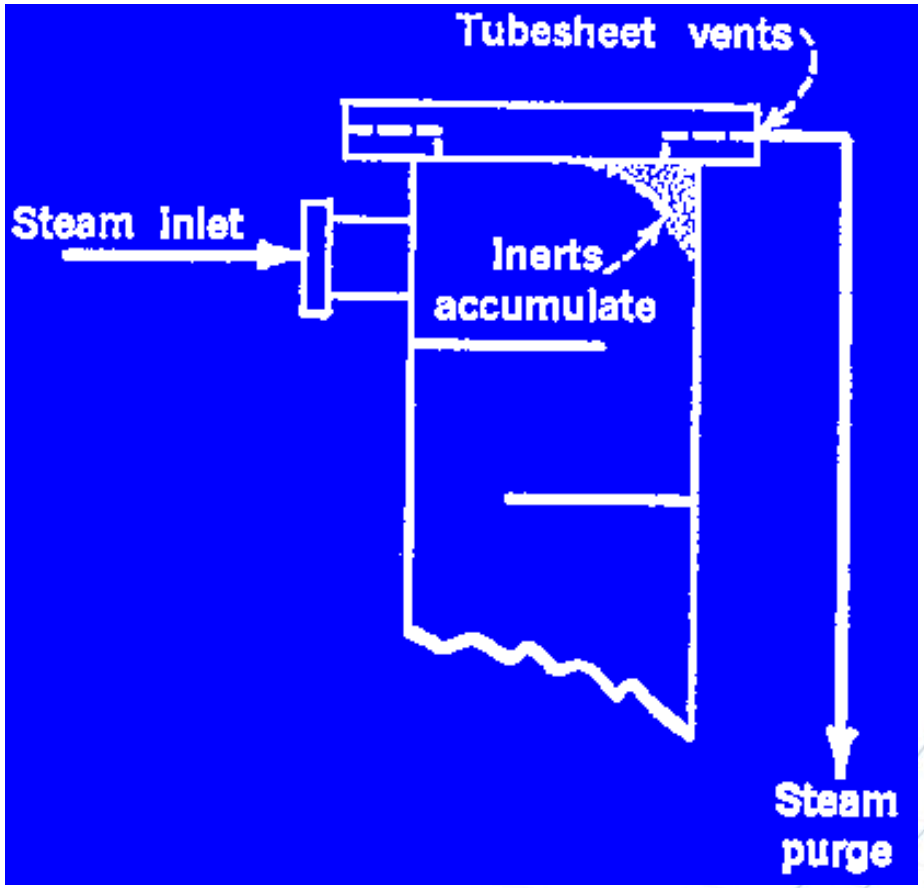


How Can We Mechanically Minimize the Problems?



Mechanical Reduction of Corrosion Potential

- Reduce air in-leakage
- Vent process equipment
- Implement proper deaeration
- Improve Sulfite Control
- Reduce feedwater alkalinity



Common Air in-Leakage Sites

- Vacuum systems (most likely source)
- Vented receivers
- Condensate pumps, traps, and valves
- Intermittently operating systems

How Can We Chemically Minimize the Problems?

Chemical Condensate Treatment

- Three Choices:
  - Neutralizing Amine
    - (This is most common and we will only be discussing this one.)
  - Filming Amines
  - Oxygen Corrosion Inhibitors

Neutralizing Amines

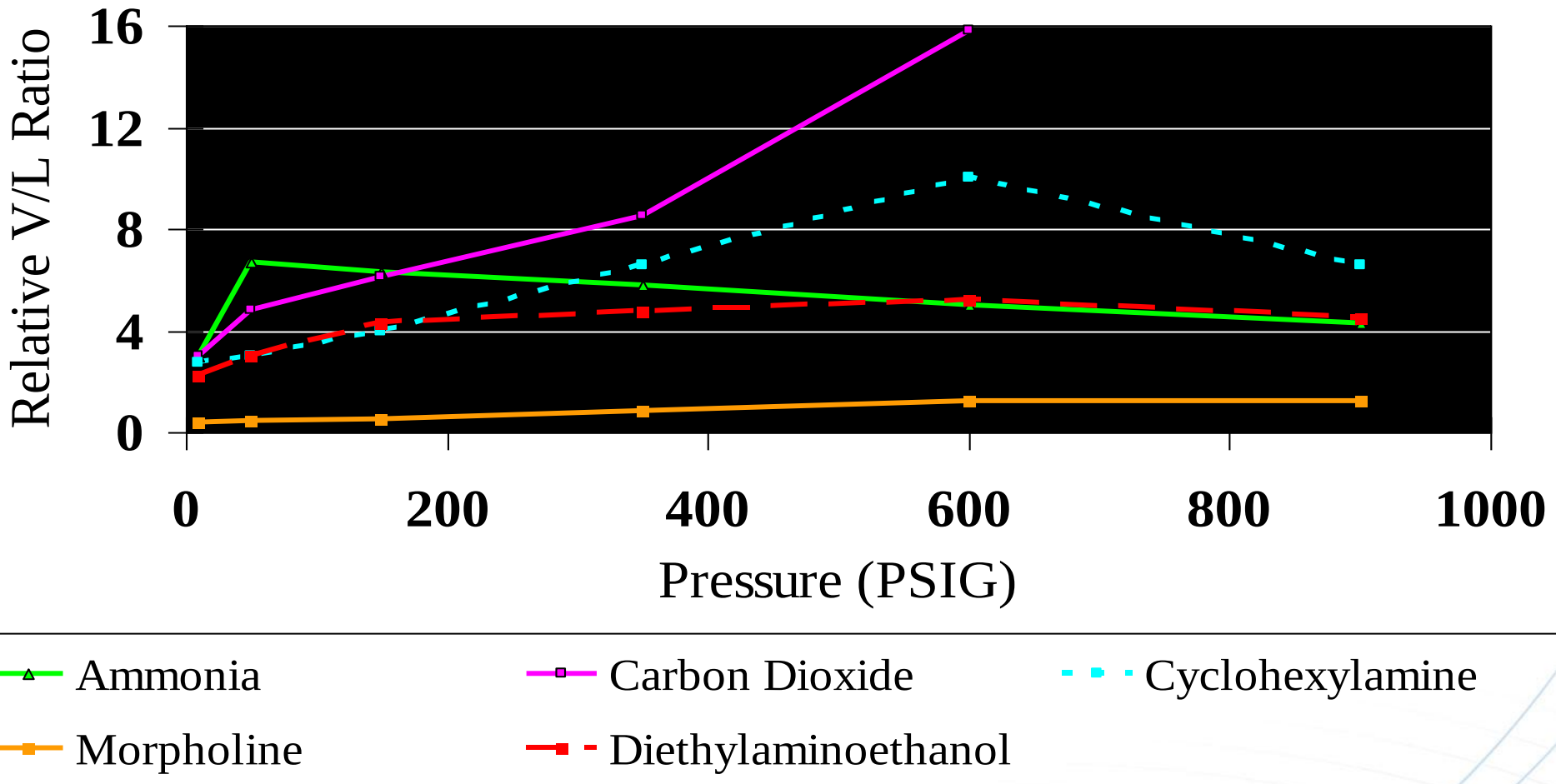
Benefits of Neutralizing Amines:

- Effective against carbonic acid corrosion
- Effective against other acids
  - Condensate systems are commonly contaminated with acidic substances
  - Neutralizing amines do not discriminate. They neutralize any acid found.
  - Often this can be seen as an increase in amine demand for no apparent reason

Neutralizing Amines Are Characterized by:

- Vapor/Liquid (V/L) Distribution Ratio
  - Molecular Weight
  - Basicity
  - Component Blend Ratio

Vapor/Liquid Distribution Ratios:



Quick Checks

- Softeners Producing <1 PPM of hardness (Not Grains Per Gallon, 1PPM=17.1GPG)
- TDS Control in Boiler (<3500 umhos), (Automation Available)
- Polishing Softener Operation (If Installed)
- Feedwater Temperature (180F Minimum)
- Operator Log Sheet testing (Daily)
- All Pumps Primed and Operating