Boiler Water Chemical Treatment

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Outlines

- Introduction
- General Water Chemistry Overview
- The Hydrological Cycle
- Heating Water Systems Overview
- Boiler Internal Treatment
- Problems with Internal Treatment
- Condensate System Operation And Troubleshooting
- Quick Checks

Boiler Water Treatment
General Water Chemistry

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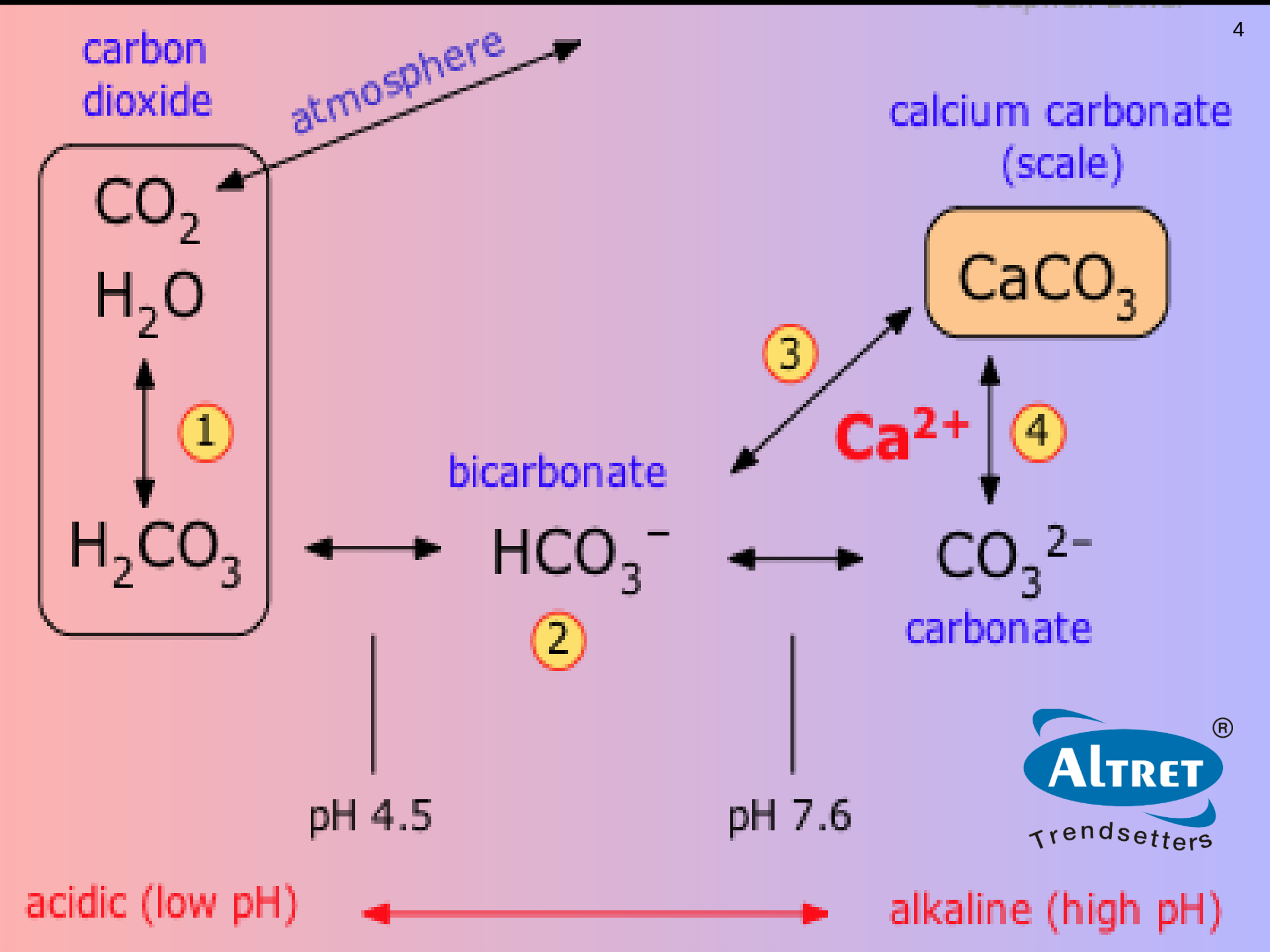
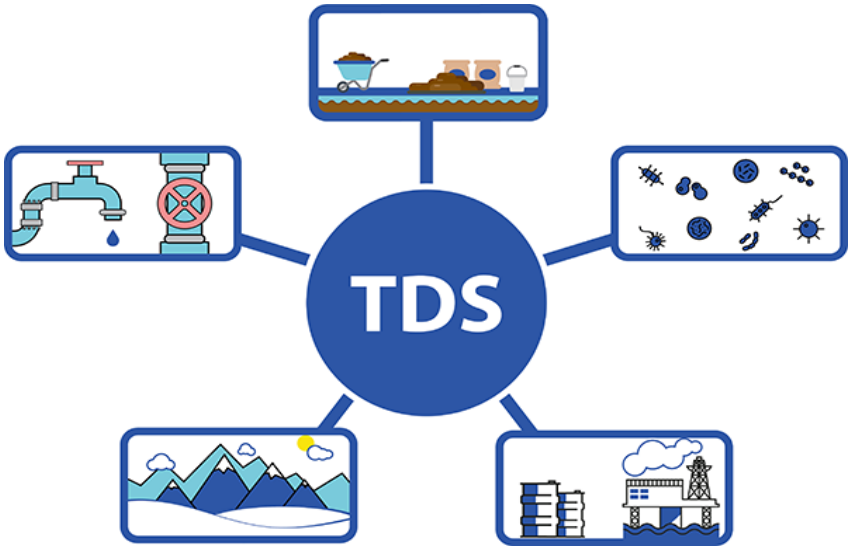


Why Use Water for Heating?

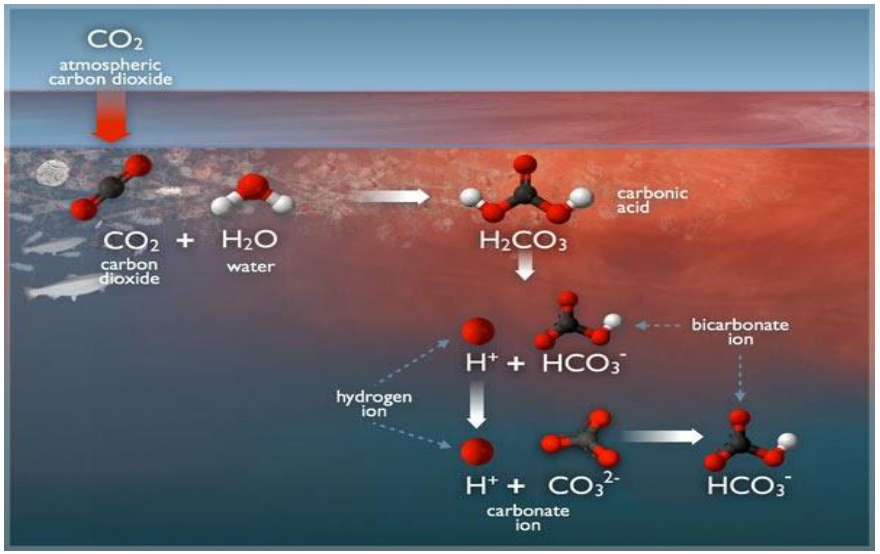
- Abundant
- Available
- Inexpensive
- Safe
- High Specific Heat
- Easy Handling & Storage

Why Isn't Water Perfect for Heating?

- Dissolved Solids



- Dissolved Gases



- Suspended Matter

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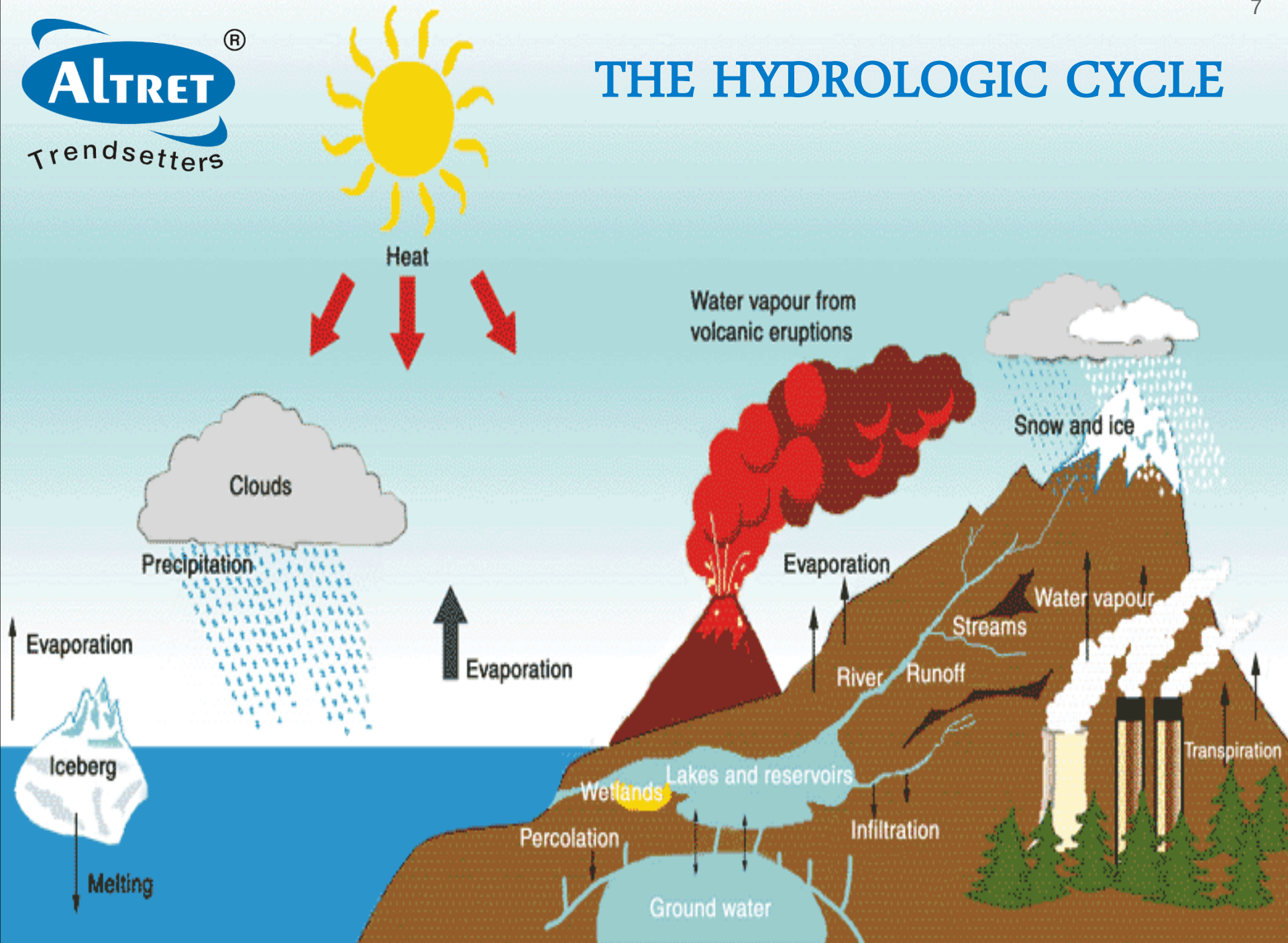
THE HYDROLOGIC CYCLE



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

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Boiler Internal Treatment

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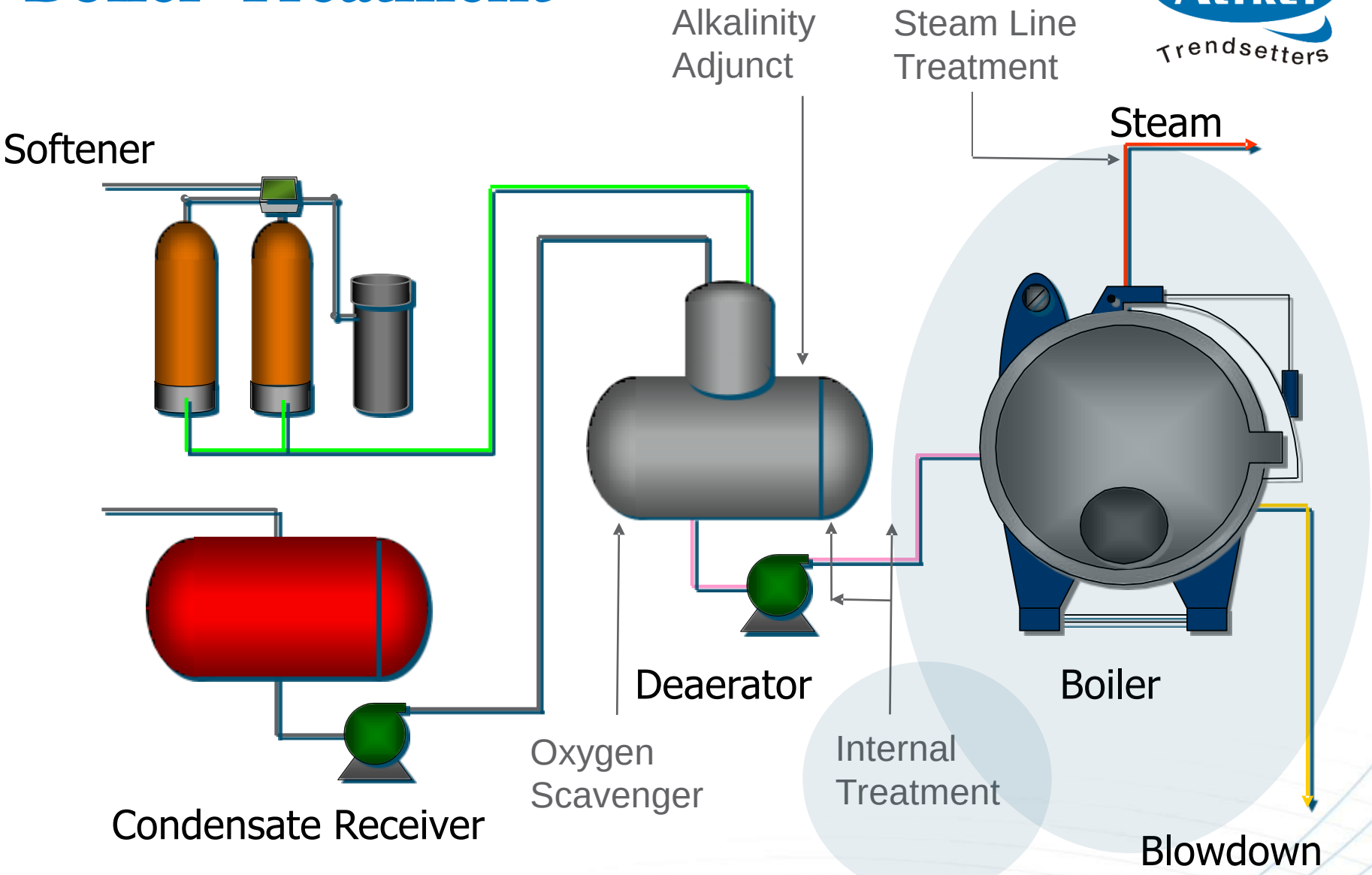
Boiler Treatment



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

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How Do We Prevent This ?

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

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What Causes Problems with Internal Treatment?

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

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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

Condensate System Operation And Troubleshooting

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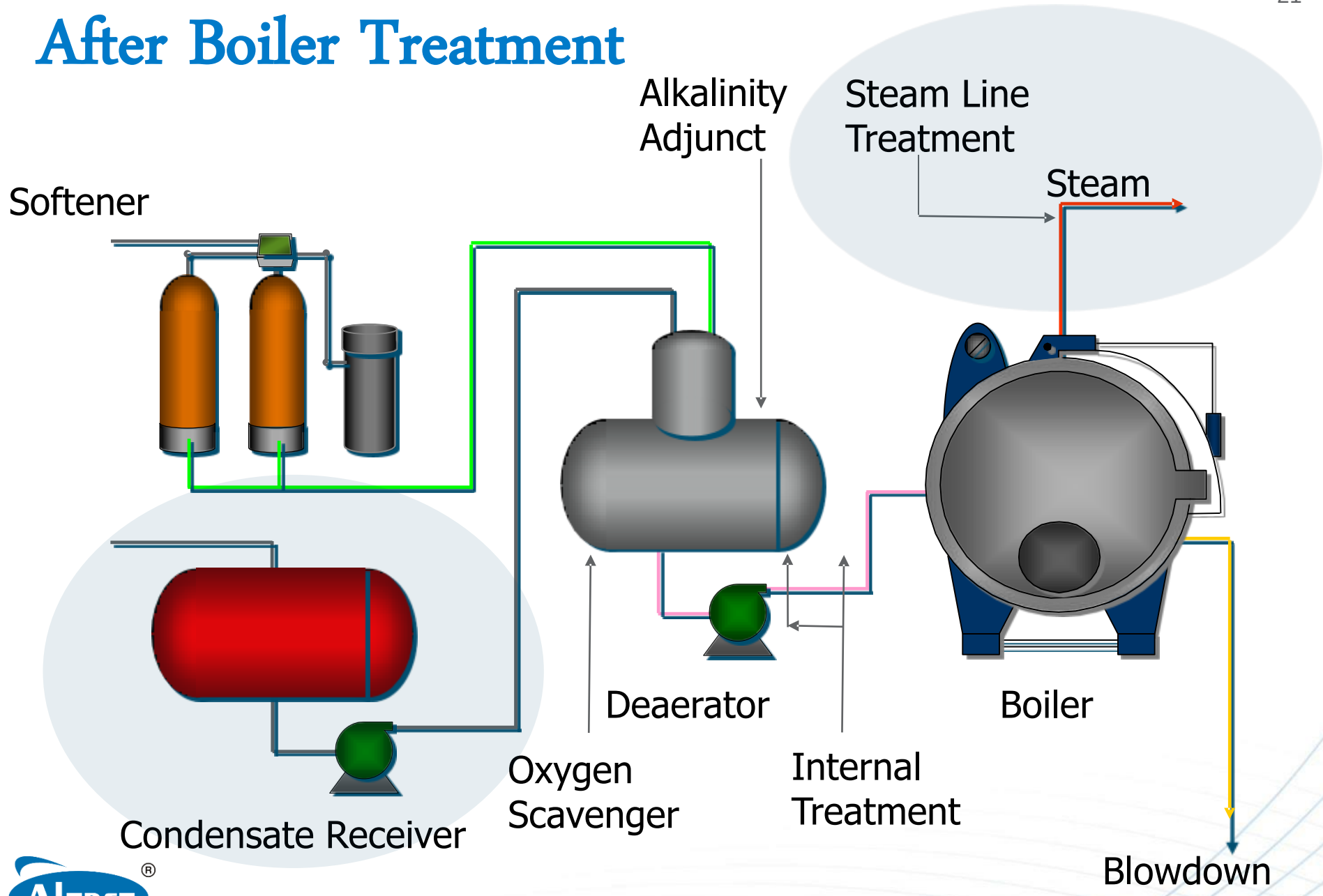
After Boiler Treatment



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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%."

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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

$$2\,HCO_3^{-1} \longrightarrow CO_3^{-2} + H_2O + CO_2$$

Bicarbonate — **Carbonate** — **Water** — **Carbon Dioxide**

$$CO_3^{-2} + H_2O \longrightarrow 2OH^- + CO_2$$

Carbonate — **Water** — **Hydroxide** — **Carbon Dioxide**

- Air in-leakage
- Organics breakdown

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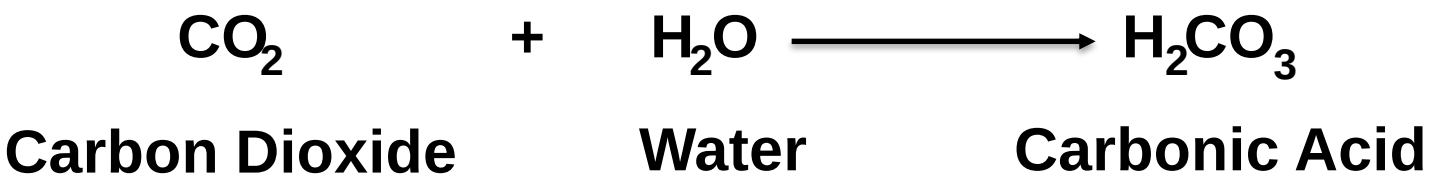
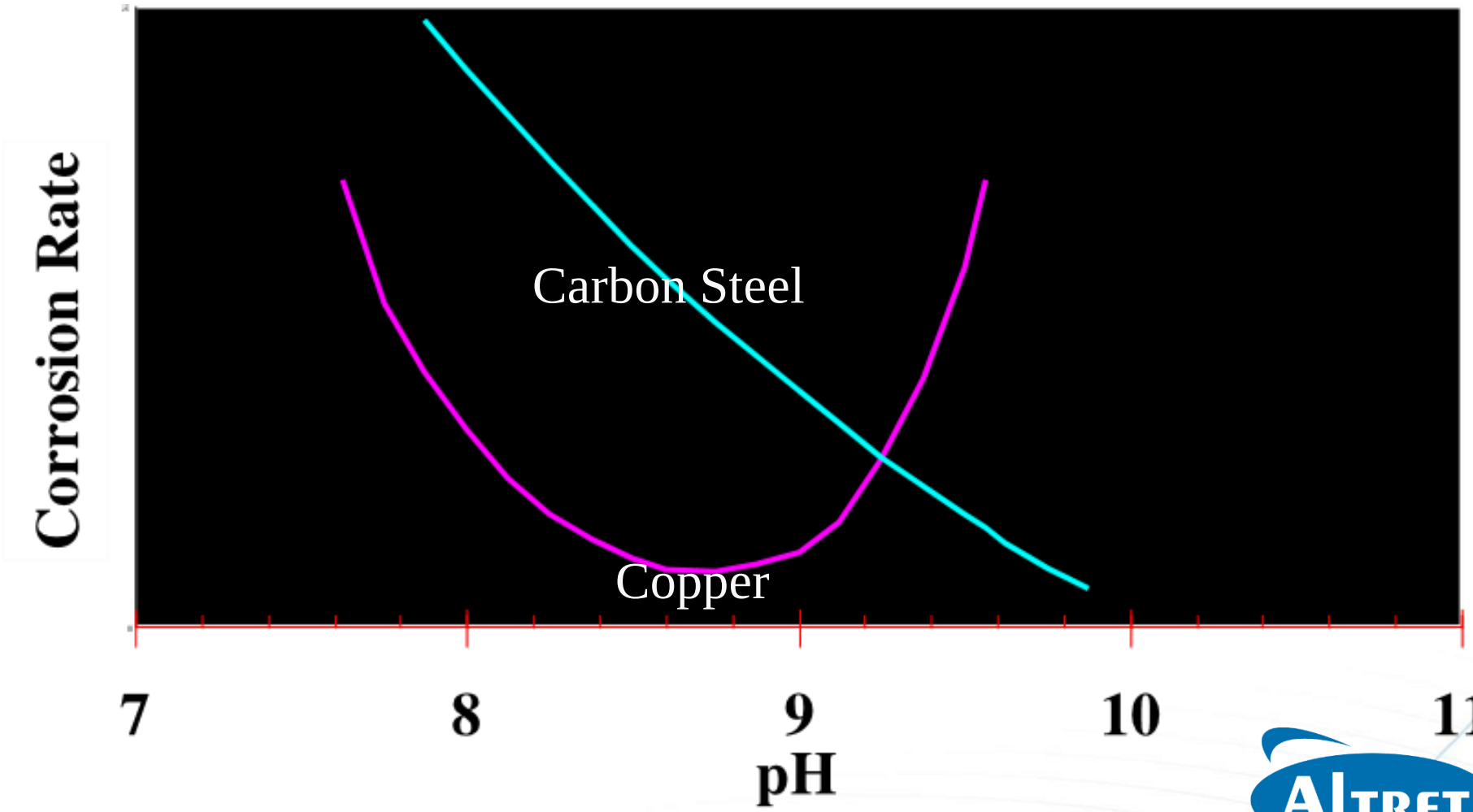
What's the Problem?

- Dissolves in the condensate forming carbonic acid



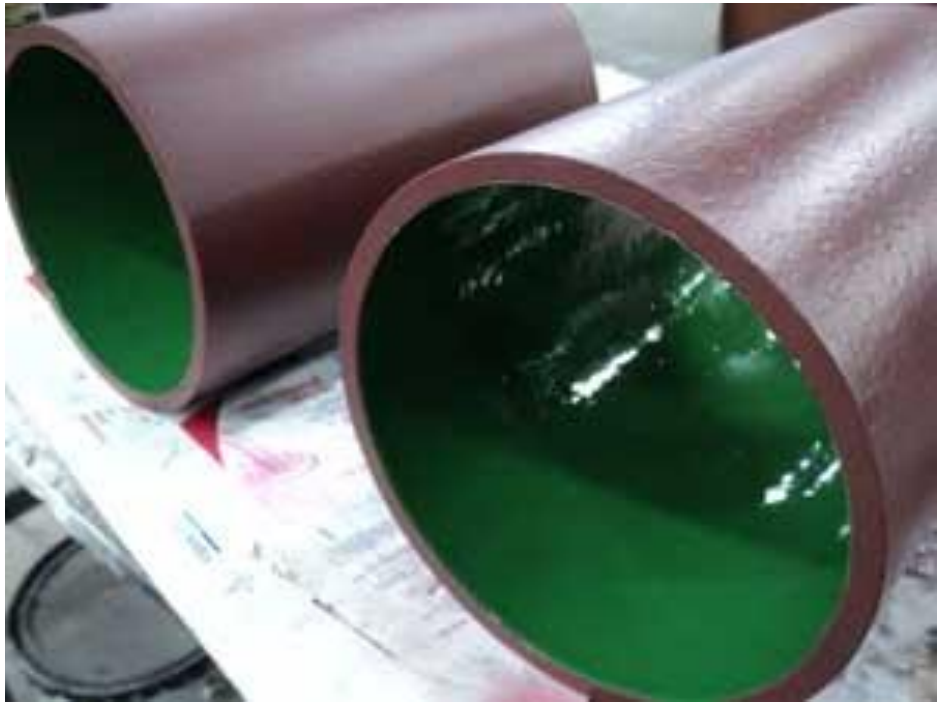
- This drops the pH in the condensate and increases corrosion rates.

Corrosion of Carbon Steel and Copper Depends on pH of Water



Carbonic Acid Corrosion

Results in a thinning and grooving of the Metal surface



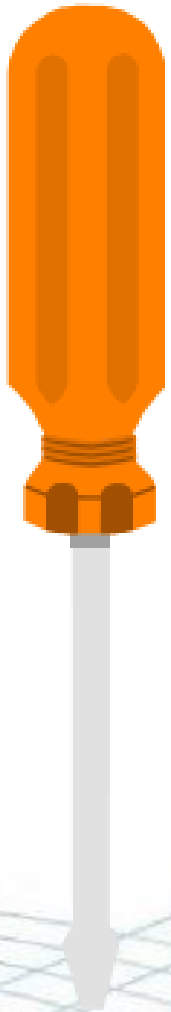
Where Does Oxygen Come From?

- 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?

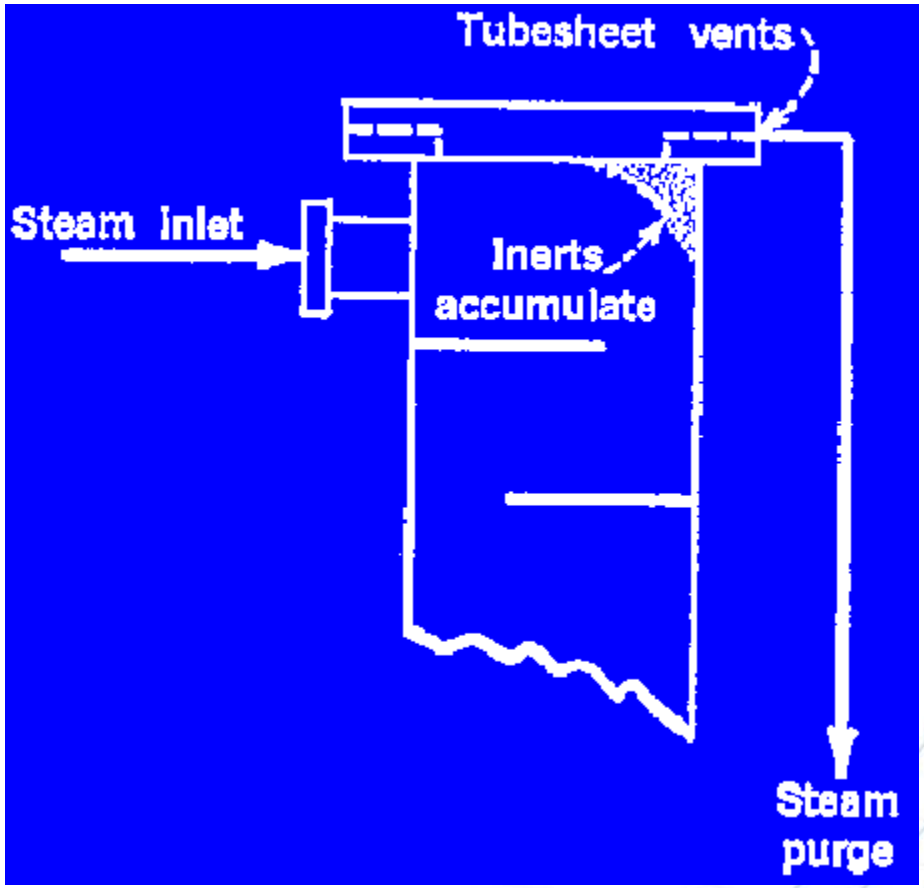
- O_2 attack results in pitting type corrosion
- Rapid localized metal loss
- Combined corrosion rate of carbon dioxide and oxygen is 10 to 40% faster than the sum of either alone...

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?

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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

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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

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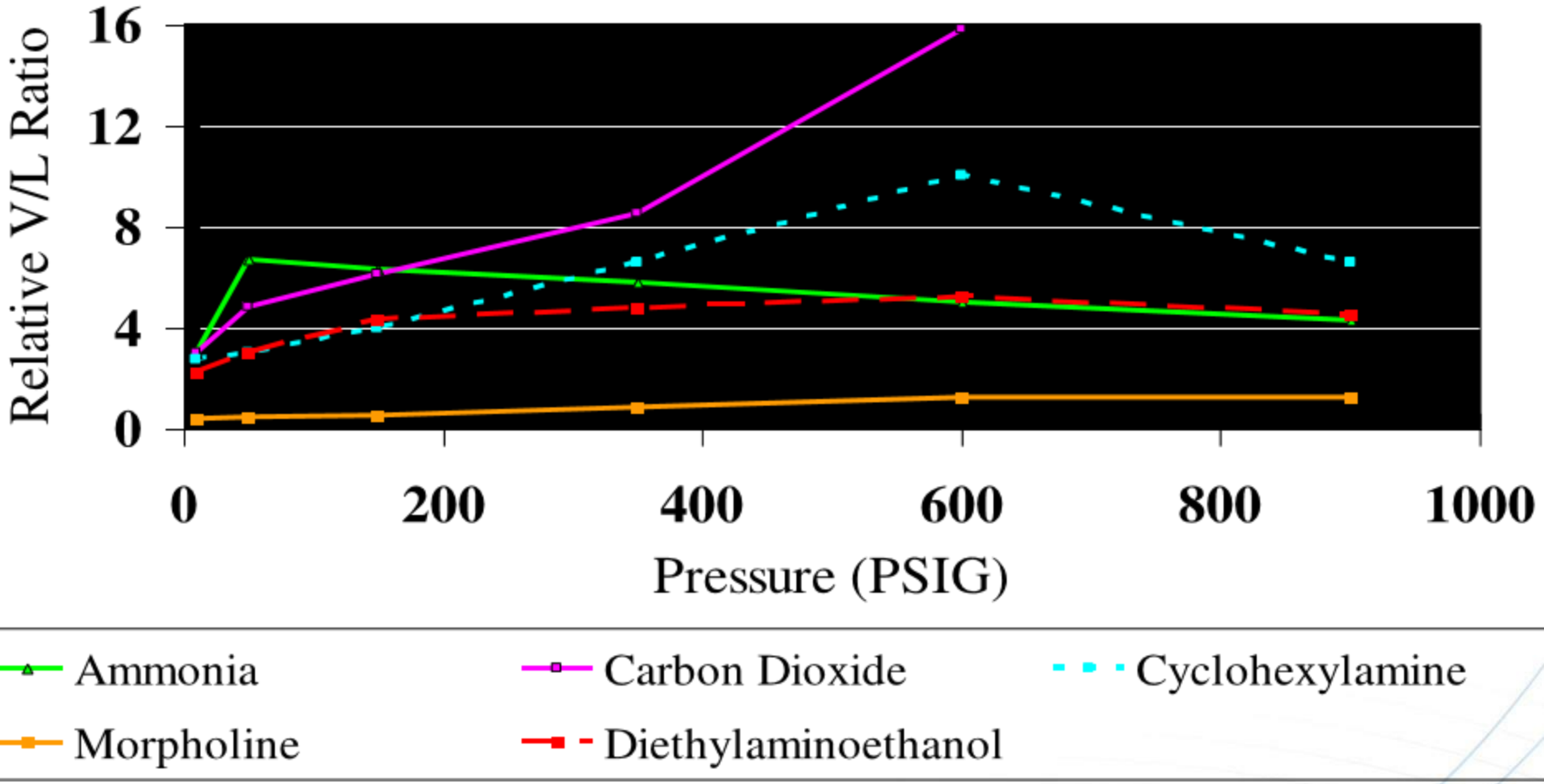
Neutralizing Amines Are Characterized by:

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

Vapor/Liquid Distribution Ratios:



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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

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Conclusions

- Proper water treatment is a combination of mechanical and chemical remediation
- Has significant impact on efficiency and reliability attainment
- Chemical treatment varies based on water tube, fire tube, pressure/temperature.
- Corrosion accelerates with temperature
- Increasing cycles of concentration saves fuel
- Heat from continuous blow down for TDS control can be recouped
- Hot water systems need to be chemically treated too

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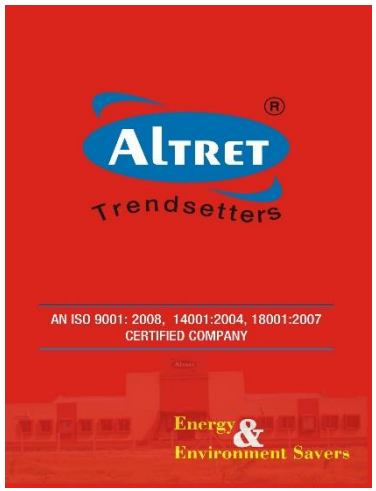
Other Product Ranges

Water treatment chemicals for Boilers & Cooling tower

Hygiene Care Specialty Cleaning Solutions

Combustion Monitoring Chemicals- Solid & Liquid Fuels Additives



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Industrial Cleaning Services

Corrosion Inhibitors, Biocides, Scale Inhibitors For Different Application

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