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Big Picture of Water Treatment Chemicals

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Boiler and cooling operators perform routine chemical tests on their water systems, record the results, and make adjustments. Do they really understand the basics of the chemistry they use? What does sulfite do? Why is phosphate added? What are phosphonates doing? In this month's edition, we will cover the "Big Picture" of what these water treatment chemicals do.

This newsletter coupled with *May 2006: Boiler and Cooling Tower Control Basics* newsletter will give the operator a good foundation for understanding water treatment chemistry and how to control it.

Boilers

The big picture of boiler water treatment chemicals is the control of scale, corrosion, and boiler carryover. Scale can lead to boiler inefficiency, plugged tubes, hot spots, under-deposit corrosion, and ultimately boiler damage. Corrosion can reduce the operating life of a boiler system and increase maintenance costs. Boiler carryover can lead to reduced steam quality and purity and cause turbine damage.

Typical boiler treatment chemicals are listed below.[1]

Oxygen Scavengers: chemically neutralize oxygen not removed by the deaerator (if present). Oxygen can lead to pitting in a boiler system.

- Sulfite/bisulfite
- Hydrazine
- DEHA (Diethylhydroxylamine)
- Carbohydrazide
- Erythorbate

Phosphates: inhibits scale formation on heat transfer surfaces.

- Orthophosphate
- Sodium tripolyphosphate
- Sodium hexametaphosphate
- TKPP (tetrapotassium pyrophosphate)
- HEDP (an organic phosphate)

Chelants: inhibits scale formation by complexing with the hardness ions.

- EDTA

Antifoams: surface-active chemicals that reduce foaming.

- Polyalkalene glycol

Neutralizing & Filming Amines: neutralizing amines protect condensate system by neutralizing effects of carbonic acid and filmers provide a protective coating.

- Morpholine
- Cyclohexylamine
- DEAE (Diethylethanolamine)
- Aminomethylpropanol
- Aqua ammonia
- ODA (Octadecylamine) – filming amine

Alkalinity Control: maintaining proper boiler alkalinity or pH protects the boiler from corrosion and facilitates certain types of chemical treatment programs (e.g., phosphate precipitation programs).

- Caustic (sodium hydroxide)
- Mono-, di-, and trisodium phosphate (coordinated phosphate control)

Polymers: disperse solids and inhibit scale.

- Polyacrylates
- Polymethacrylates
- Polymaleic acid
- Polyacrylate/acrylamide
- Acrylate/AMPS/sulfonated styrene terpolymer

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- Acrylate/sulfonic acid/nonionic terpolymer

Cooling Towers

The big picture of cooling tower water treatment chemicals is the control of scale, corrosion, microbiological activity, and foaming. Scale can lead to heat exchanger inefficiency, plugged tubes, inadequate flow, and under-deposit corrosion. Corrosion can reduce the operating life of cooling equipment and increase maintenance costs. Microbiological activity can lead to reduced heat exchanger efficiency, plugged tubes, inadequate flow through the cooling tower fill, under-deposit corrosion, etc.

Typical cooling tower treatment chemicals are listed below. [1]

- **Corrosion Inhibitors**: to protect metal surfaces from corrosion.
  - Phosphates (orthophosphate, sodium tripolyphosphate, sodium hexametaphosphate, TKPP)
  - Phosphonates (HPA and others)
  - Zinc
  - Silicates
  - TT (Tolyltriazole – for yellow metals)
  - BZT (Benzotriazole – for yellow metals)
  - Molybdate
- **Scale Inhibitors**: to protect heat transfer surfaces and cooling system from scale.
  - Phosphates (sodium tripolyphosphate, sodium hexametaphosphate, TKPP)
  - Phosphonates (HEDP, AMP, PBTC)
  - Polymers (polycarboxylates, polyacrylates, polymaleic acid, maleic anhydride copolymer, acrylate/AMPS copolymer, acrylate/AMPS/sulfonated styrene terpolymer, acrylate/sulfonic acid/nonionic terpolymer) – many are dispersants too.
- **Antifoams**: surface-active chemicals that reduce foaming.
  - Silicone and non-silicone blends
- **Biocides**: for microbiological control.
  - Oxidizing biocides (bleach, bromine, chlorine gas, BCDMH, calcium hypochlorite, chlorine dioxide, hydrogen peroxide, iodine, ozone)
  - Nonoxidizing biocides (isothiazolin, gluteraldehyde, DBNPA, MBT)

Closed Loops

For closed loops, the big picture of water treatment chemicals is to control corrosion and microbiological activity. Corrosion can lead to equipment failure and increased maintenance costs. Microbiological activity can lead to reduced heat exchanger efficiency, plugged tubes, and under-deposit corrosion.

Typical closed loop treatment chemicals are listed below. [1]

- **Corrosion Inhibitors**: to protect metal surfaces from corrosion.
  - Nitrites
  - Zinc
  - Silicates
  - TT (Tolyltriazole – for yellow metals)
  - BZT (Benzotriazole – for yellow metals)
  - Molybdate
  - Sulfite
  - pH control (caustic, borates, etc.)
  - VpCI (Volatile Phase Corrosion Inhibitors)

- **Biocides**: for microbiological control.
    - Nonoxidizing biocides (isothiazolin, gluteraldehyde, DBNPA, MBT)

Conclusions

Chemical treatment is only one method to control scale, corrosion, microbiological activity, and foaming/carryover. External treatment (e.g., softeners, reverse osmosis), good process control, proper maintenance of equipment, and excellent operational procedures must be part of the picture too.

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