NON-HAZARDOUS CHEMICAL TREATMENTS FOR HEATING AND COOLING SYSTEMS

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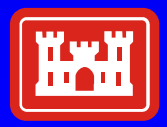
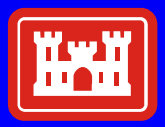
What Are "Green" Chemical Treatments?

- Reduce corrosion, biological growth and scale in heating and cooling plants with treatments that are
  - Less toxic
  - Not environmentally persistent
  - Not bioaccumulative
  - Biodegradable to nontoxic byproducts
  - Efficient in their manufacturing process
  - Delivered into the system when needed, in correct amount



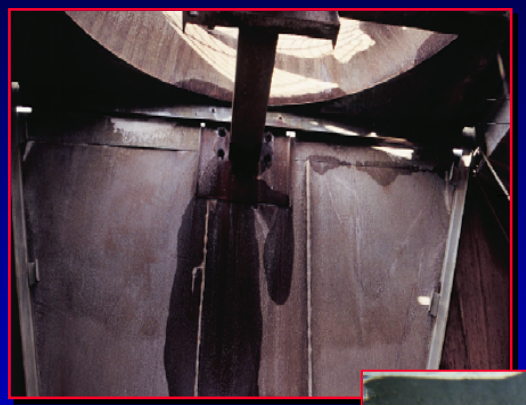
Heating and Cooling Impact on Mission

- Reliable operation of heating and cooling plants is critical to
  - Maintenance of mission-critical electronic equipment and computers
  - Training
  - Plant safety
  - Welfare of soldiers and their families



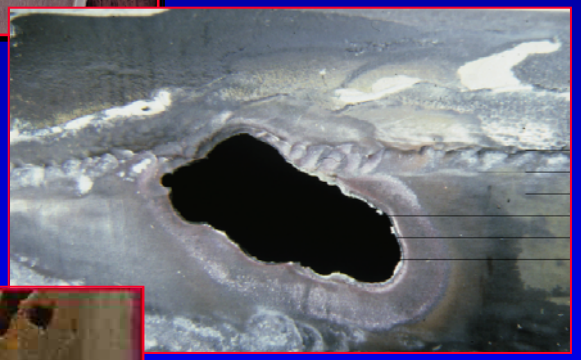
Background
Why is the effort needed?

- Lack of current and consistent guidelines for new water treatments
- Reduced system reliability and efficiency
- Premature failure of system components.



Poor control of acid feed strips galvanizing

Boiler Tube – Oxygen Pitting Failure

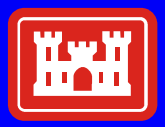


Boiler Feedwater Piping – 6 Months Deaerator Not Working Properly

Background
Why is the effort needed?

Current practice for chemical monitoring and control:

- is maintenance intensive
- requires a skilled technician
- requires direct contact with hazardous chemicals
- provides inconsistent dosing of chemicals and inconsistent levels of protection
- is costly



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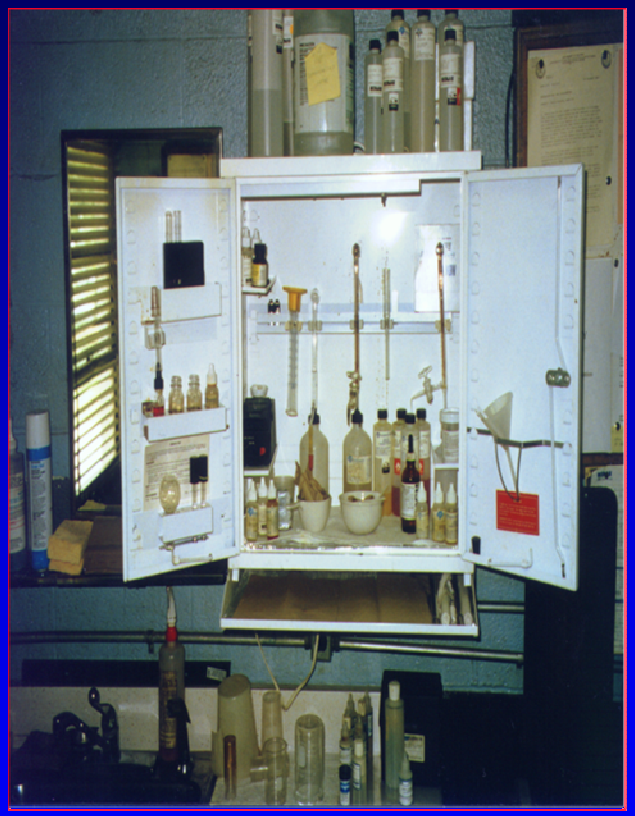
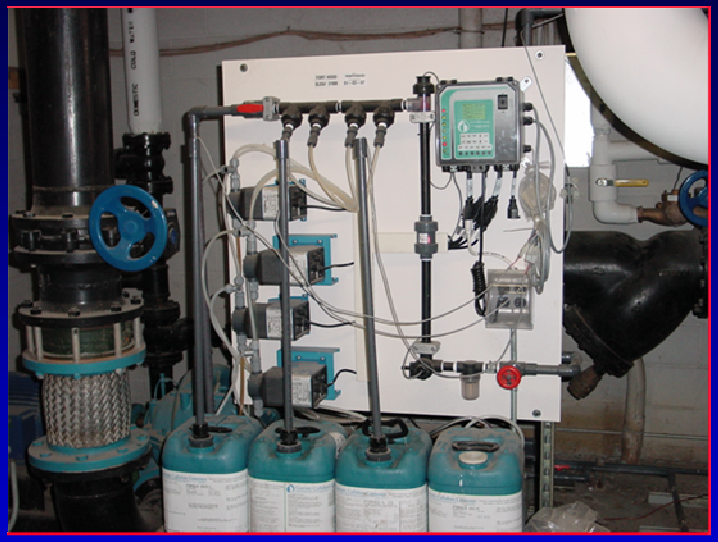


Current Practices

Objective



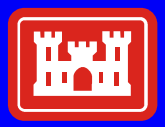
Continuous monitoring and controlled dosage of environmentally friendly "green" chemicals

Technical Objectives

- Green Chemical formulations for corrosion and scale inhibitors and biocides.
- Smart monitoring and control systems for chemical dosing
- Improve reliability and security of heating and cooling systems
- Minimize the manpower and capital investment needed to operate heating and cooling systems
- Provide guidance to the field on use of green chemical treatments for heating and cooling systems

Technical Approach

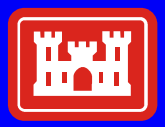
- Pilot tests at three Army installations of
  - Scale inhibitor
  - Cooling tower biocide
  - Filming amine corrosion inhibitor
  - Automated monitoring and dosing system



Green Chemical Formulations

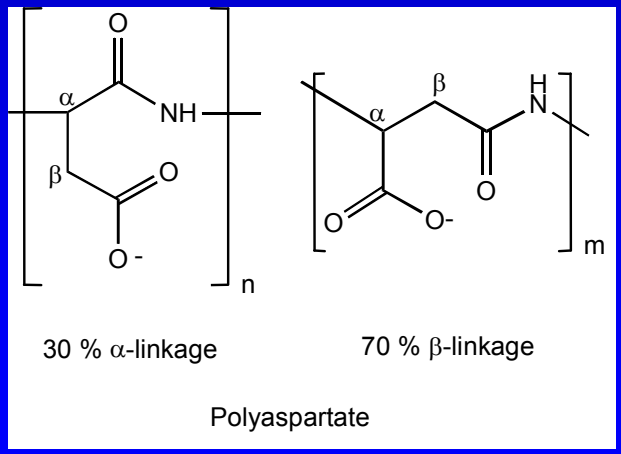
Three Army installations were selected for pilot testing of environmentally friendly chemical treatments:

- polyaspartate (PASP) scale inhibitor
- tetrakis (hydroxymethyl) phosphonium sulfate (THPS) biocide
- biodegradable filming amine corrosion inhibitor



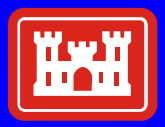
Polyaspartate (PASP) Scale Inhibitor

- Polyaspartate (PASP) Scale Inhibitor
  - water-soluble dispersant
  - prevents formation of calcium carbonate, calcium sulfate and barium sulfate
  - can replace the environmentally persistent polyacrylates



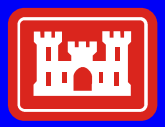
Polyaspartate (PASP) Scale Inhibitor

- Developed for moderate hardness and alkalinity
- Biodegrades with bacterial action
- Has an efficient manufacturing process that is virtually waste-free
- Is formulated for use in open recirculating cooling systems



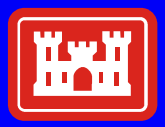
Polyaspartate (PASP) Scale Inhibitor

- PASP scale inhibitors were developed by Garratt-Callahan Company
  - Formula G-C 2600 for waters with moderate hardness and alkalinity
  - Formula G-C 2610 for waters of high hardness and high alkalinity
- Treatment dosage levels are 100 – 150 ppm
- Formulas also contained corrosion inhibitors and a molybdenum tracer to track dosage levels



Polyaspartate (PASP) Scale Inhibitor

- Results
  - PASP did not change the operating performance of the equipment
  - Product appears to have good dispersion qualities
  - Scale prevention on heat exchanger tubes was effective at both sites



Tetrakis (Hydroxymethyl) Phosphonium Sulfate (THPS)

- Broad spectrum, non-foaming, microbiocide
- Benign environmental toxicity profile
- Degrades rapidly upon discharge through hydrolysis, oxidation, photodegradation, and biodegradation.
- Stable and effective over a pH range of 3 - 10.
- Controls slime-forming bacteria and algae in recirculating water cooling systems, industrial process water systems and air scrubbers.
- May be used to control aerobic and anaerobic bacteria, especially sulfate reducing bacteria.

Bacteria Counts at Ft. Hood Cooling Tower

Date	Aerobic Bacteria	Anaerobic Bacteria
July 10	10^4	0
July 31	10^3	0
August 8	10^3	0
August 20	10^3	0
August 27	10^4	0
September 5	10^5	0
September 11	10^5	0
September 18	10^4	0
September 26	10^3	0
October 2	10^3	0
October 9	10^4	0
October 16	10^4	0
October 23	10^5	0
October 31	10^3	0
November 5	10^3	0
November 12	10^4	0
November 20	10^3	0
November 27	10^3	0

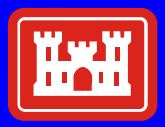
(Bacteria counts are less than 10^6 are considered excellent)

Tetrakis (hydroxymethyl) phosphonium sulfate (THPS)

- Results
  - Provided good aerobic and anaerobic bacteria control
  - Limited success with algae control
  - Will be most effective when alternated with an oxidizing biocide

Filming Amine Corrosion Inhibitor

- A filming inhibitor for the condensate systems made from exthoxalated soya products per specifications.
- Controls corrosion in steam condensate return systems by forming a thin, non-wettable, protective thin film barrier on metal surfaces.
- Garratt-Callahan Formula 4055



Filming Amine Corrosion Inhibitor

Benefits of Efficient Chemical Treatment

- Reduced maintenance needs
- Reduced outages/loss of service---critical!
- Green chemicals increase health and safety-- critical!
- Reduced water and chemical usage
- Extended equipment life
- Research shows that it works!

Summary

- "Smart" monitoring and dosing systems can aid in maintaining optimum conditions and eliminate overuse of chemicals
- PASP is a "greener" approach to reduce mineral scale
- THPS is effective in reducing bacteria, and can work with an oxidizing biocide to control algae
- Ethoxalated soya filming amines show promise as effective corrosion inhibitors

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