POTENTIAL ENERGY AND COST SAVINGS THROUGH PROPER TREATMENT OF HEATING AND COOLING SYSTEMS

A Webinar for Facility Managers and Operators at Institutional and Industrial Facilities October 16, 2018

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MAIN FACTORS AFFECTING COSTS



- 1. ENERGY EFFCIENCY: HEAT TRANSFER
- 2. MAINTENANCE AND REPAIR
- 3. EQUIPMENT LIFE / REPLACEMENT
- 4. WATER, SEWER, TREATMENT CHEMICAL

IMPACTS OF POOR WATER TREATMENT







IMPACTS OF POOR WATER TREATMENT

Mineral Scale, Corrosion, Biological Growth

Reduce equipment life

 Increase maintenance / cleaning costs / labor costs

IMPACTS OF POOR WATER TREATMENT

Increased blowdown / bleed in boilers, cooling towers

Higher water, sewer, and treatment chemical costs

Lower energy efficiency for steam boiler if no heat recovery from blowdown

STEAM BOILER SYSTEMS





STEAM BOILER SYSTEMS

Poor treatment / control can cause scale deposits

Reduce boiler efficiency significantly

- 1/16 inch scale → 4 11% loss of efficiency
- 1/8 inch \rightarrow ~ up to 18% loss of efficiency

Can result in ruptured tubes (overheating)

Increases cleaning (de-scaling) / maint. costs

EFFECT OF DEPOSITS ON HEAT TRANSFER EFFICIENCY





STEAM BOILER, WATER DIAGRAM



Cycles of Concentration (COC)

- Number of times dissolved solids in the feedwater are concentrated in the boiler.
- Conductivity or chloride can be used to estimate.
 - Example: Feedwater conductivity = 100 uS/cm, Boiler = 3000 uS/cm. Boiler COC based on feedwater = 3000/100 = 30.
- COC should be > 40, otherwise room for improvement

PERCENT BLOWDOWN

Calculate directly from COC.

%Blowdown = 100/COC.
 Example: COC = 10, Blowdown = 100/10 = 10% increase to 40, Blowdown = 100/40 = 2.5%
 Blowdown is lost water and treatment chemicals

Blowdown means Fuel lost!

 Energy (Fuel) is consumed by water that is blown down the drain!

STEAM BOILER SYSTEMS

Often, if treatment / control are poor, blowdown (bleed) can be reduced resulting in:

- Higher Cycles of Concentration
- Energy / Fuel savings, due to less blowdown
- Reduced treatment chemical use
- Reduced water use (less make-up water)

REVERSE OSMOSIS SYSTEMS

RENAUTE RETURN 🐟

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STEAM BOILER SYSTEMS

- Reverse Osmosis (RO) System
 - RO provides very clean water, resulting in higher COC in boiler and reduced blowdown (up to 70% lower)
 - Significantly decreases boiler energy/ fuel use,
 ~ 5% or more depending on thickness of original scale
 - Treatment chemical use decreases 50 90%
 - Greatly reduces need for boiler cleaning, can remove existing scale
 - Lower alkalinity reduces corrosivity of condensate; can increase condensate purity by reducing carryover

WHEN IS AN RO SYSTEM ECONOMICAL?

- If you have poor quality Feedwater (conductivity > 100 uS/cm)
- If system has a high make-up rate (typically > 20 %)
- Larger boiler systems (typically > 350 Boiler Horse Power)
- Must be determined case by case
- Typical payback 1 2 years

COOLING TOWERS / EVAPORATIVE CONDENSERS



EFFECTS OF POOR WATER TREATMENT

MINERAL SCALE DEPOSITS

- CORROSION
- BACTERIA, ALGAE, BIOFILM ON SURFACE

■ LEGIONELLA BACTERIA → HEALTH RISK

MINERAL SCALE DEPOSITS

REDUCE COOLING TOWER EFFICIENCY
 Increase electricity use & cost

REDUCE CHILLER ENERGY EFFICIENCY

- 1/32" scale on condenser → ~ 9% reduction
- 1/16" scale \rightarrow ~ 14% reduction
- INCREASE CLEANING / MAINT. COSTS
 Cooling Tower & Chiller (condenser tubes)







CORROSION

DEPOSITS REDUCE TOWER AND CHILLER EFFICIENCY

- REDUCE LIFE OF CHILLER AND TOWER
- INCREASE DIFFICULTY OF REMOVING BACTERIA / BIOFILMS



BACTERIA / BIOFILM

VERY LOW HEAT TRANSFER COEFFICIENT

- Reduces chiller efficiency greatly
- 1/16" film \rightarrow up to 35% loss of efficiency
- INCREASES CORROSION UNDER THE BIOFILM
 - Reduces life of Chiller tubes and Tower
 - Increases maint. / repair costs
- CAN CAUSE LEGIONNAIRES' DISEASE
 - Transmitted by inhaling droplets / mist
 - Biofilm protects Legionella bacteria







Legionella Pneumophilia



Cooling Tower Water Usage

COC	Evap.	Blowdown	Total Used
1.5	5000	10000	15000
2.0	5000	5000	10000
3.0	5000	2500	7500
4.0	5000	1667	6667
5.0	5000	1250	6250
6.0	5000	1000	6000
7.0	5000	833	5833
8.0	5000	714	5714
9.0	5000	625	5625
10.0	5000	556	5556

Cooling Tower Chemical Usage

COC	Dosage	Tower
	lb/1000 gal	Conc. mg/L
1.5	0.67	1.0
2.0	0.50	1.0
3.0	0.33	1.0
4.0	0.25	1.0
5.0	0.20	1.0
6.0	0.17	1.0
7.0	0.14	1.0
8.0	0.13	1.0
9.0	0.11	1.0
10.0	0.10	1.0

COOLING TOWERS / EVAPORATIVE CONDENSERS

If chemical treatment / control is poor or non-existent, a good treatment program can:

- Reduce energy use in chiller (and tower)
 - \$10,800 saved /yr, for 500 ton chiller, 6 months, 12 hrs/ day, 0.9 KWH/ton, \$0.08/kWh, after 1/16" scale removed
- Reduce water and sewer use
- Reduce treatment chemical use
- Reduce operating costs
- Reduce equipment maintenance costs
- Prolong equipment life
- Reduce the risk of Legionnaires' Disease

CLOSED LOOP HEATING & COOLING SYSTEMS

CLOSED LOOP HEATING & COOLING SYSTEMS

- Filled with water or solutions of ethylene or propylene glycol
- No exposure to the atmosphere, normally no evaporation of water
- Ideally loses less than 5% of system volume per year.
 - Reality: many systems have larger leaks
- Transfer heat or cooling from equipment such as heat exchangers, chillers, and boilers to the areas that require heating or cooling.
- Various types: Low Temperature Hot Water (LTHW), Medium Temperature Water (MTW), High Temperature Hot Water (HTHW or HTW), Chilled Water (CW), ALSO GEOTHERMAL LOOPS.





EFFECTS OF POOR / NO WATER TREATMENT

- Corrosion or poor protection from corrosion; leaks !
- Microbiological growth: Bacteria / Fungi
 - < 55 deg. C (131 deg. F) and no glycol present. Also found in higher temp systems if dead legs / low flow areas.
 - Cause corrosion, can produce ammonia
- High Ammonia: very corrosive to copper
- Glycol systems can experience decomposition with age, high temp, or due to bacteria if glycol concentration < 20%. Decomposed glycol typically has a low pH and is very corrosive.





INSTITUTIONAL WATER TREATMENT PROGRAM (IWT)



Started in 1949 at IL. State Water Survey. Founder: Russel W. Lane, published book on water treatment, © 1993

- 69 Years of experience in water treatment. Service and consulting: institutional / industrial heating/cooling systems, potable water
- Numerous research projects: Corrosion, lead/copper, scale, cooling tower treatment, potable water treatment, monitoring tech, "gadgets" (esp. magnets)

OVERVIEW OF PROGRAM

- Currently serve ~120 facilities in IL., including Prisons, Mental Health Centers, Universities, High Rise buildings
- Saves State Millions \$ annually: energy, water, treatment chemicals, maintenance, equipment
- Can also save private companies \$, past projects: heating/cooling system evaluation, treatment consulting, cooling tower treatment technologies (evaluation)

SERVICES OFFERED

- 1. On-Site Corrosion Testing / Monitoring
- 2. Thorough, Unbiased Lab Analysis
 - Water and Glycol samples
 - Corrosion and Deposit samples (solids /sludge)

3. Unbiased Ongoing Water Treatment Service and Consulting (what we do for current clients): heating, cooling, potable water systems

- 4. 3rd Party Audit of water systems
 - Energy, Water, Chemical savings
 - Deficiencies in current treatment program

ON-SITE CORROSION TESTING

Standard Test Method using metal test specimens (coupons)

- Various metals; Mild Steel and Copper most common
- Specimens installed in system for 3 12 months
- Corrosion rate determined by weight loss of metal





IWT LAB ANALYSIS OF WATER SAMPLES

- Very thorough analyses
- Have developed some custom analytical methods for specific systems
- Capability to analyze > 50 different key parameters in heating, cooling, boiler, condensate, make-up (ie: Softener, RO), raw (wells, lakes, rivers), and potable water systems

IWT LAB ANALYSIS OF WATER SAMPLES

Benefits of Lab Analysis:

- Unbiased 3rd party results
- Find evidence of corrosion
- Determine scale and corrosion indices (Potable)
- Bacteria + Fungi levels: Cooling Tower, Closed Loops, other
- Determine corrosion & scale inhibitor levels
- Determine metals present
- Expert report of results including recommendations

IWT LAB ANALYSIS OF SCALE AND DEPOSITS

Benefits:

- Can help determine source / cause of deposit
- Info can be used to recommend a solution
- Knowledge of presence / absence of metals

WATER TREATMENT SERVICE AND CONSULTING

- Begins with evaluation of source water and current systems: design and materials of construction
- Then, treatment plan developed for each system
 - Treatment control charts for operators
 - Includes recommended on-site tests, intervals
- If needed, system operators can be trained on test procedures and treatment application
- IWT Field Chemist visits 1 6 times per year
 - Test systems, collect samples for lab, report

Benefits of Ongoing IWT Service

Control of corrosion, scale, and biofouling

- Increases energy / water efficiency
- Reduces chemical treatment costs
- Reduces maintenance / cleaning costs
- Extends equipment life
- Reduces system down-time
- Reduces risk of Legionnaire's Disease from Recirc. Domestic Hot Water and Cooling Towers
- IWT monitors trends, can prevent serious damage

Benefits of Continual IWT Service (cont.)

- Can detect changes in source water quality which will affect systems, and then change treatment plan
- Provide consulting for client questions (phone, e-mail)
- Can ensure compliance with wastewater discharge permits and regulations (ie: molybdenum in Cooling Tower Blowdown water)
- Can provide annual water and energy efficiency reports (if client has data)

UNBIASED 3RD PARTY AUDIT OF WATER SYSTEMS

Evaluate individual systems

- Look for potential for reducing energy, water, and treatment chemical use; <u>unbiased</u> <u>assessment</u>
- Determine performance of current treatment, a second set of eyes
- Discover possible deficiencies: Corrosion, Scale, Biofouling, unsafe Dom Hot Water condition (Legionnaire's Disease risk), degraded testing chemicals

UNBIASED 3RD PARTY AUDIT (CONT.)

- Collect equipment, history, current treatment, and operating data on-site
- Test system samples on-site
- Collect samples for full lab analysis (water, glycol, scale /deposit)

UNBIASED 3RD PARTY AUDIT (CONT.)

- Use data and sample results to evaluate present treatment and control of system
- List any deficiencies found
- For State institutions (IL), we can recommend chemicals from the state bid list, often 10x less \$ than proprietary treatment from a vendor.
- Give <u>unbiased</u> recommendations to mitigate any deficiencies or problems found, and treatment and control changes that will improve energy, water, and/or chemical treatment efficiency and thus save \$

INSTITUTIONAL WATER TREATMENT SERVICES

CONTACT US TO SCHEDULE A SITE VISIT!



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