Water Treatment for Conservation

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Water Treatment Fundamentals

Purpose – to control or prevent:

- Corrosion of steel and yellow metals (copper, brass)
- Scale formation from minerals in hard water
- Biological growth – bacteria, algae, slime
- Extend life of equipment
- Maximize heat transfer efficiency (saves fuel and pumping)

Systems treated:

- Closed hydronic loops – HW, CHW – boilers, chillers
- Cooling towers
- Steam boilers

Systems at Cal Poly SLO

Main Campus Central Plant:

- Three 20MMBtu hot water boilers – 180F, 250,000 gal
- Four 300 ton, one 1350 ton chillers – 40F
- 1.6 Mgal TES tank
- Two 1350 ton cooling towers
- 1 mile long distribution loop – Utilidor

Treatment protocols:

- HW system – silicate, soft makeup
- CHW system – molybdate, ClO2 (Chlorine Dioxide)

Systems at Cal Poly SLO

- Satellite boiler/cogen plant at Poly Canyon Village
- 12 remote steam boilers for process loads
- 12 remote HW/CHW closed loops
- 6 Remote chillers/cooling towers in Red Brick halls
- Treatment protocols:
  - Closed loops – nitrite
  - Steam boilers – polyphosphate/sulfite, soft makeup
  - Cooling towers – scale inhibitor, biocide
- Steam boilers and cooling towers require **blowdown**
- Must clean, passivate, and treat all new piping
- Annual water treatment program spend ~$200K

Opportunities for Savings

- Prevent leaks, repair leaks promptly
- Prevent scaling/fouling – improves efficiency of:
  - Boilers, chillers, and cooling towers: fuel = $
  - Heat exchangers – HHW, DHW, AHU coils: dT = $
- Minimize blowdown losses: water, sewer, heat, chemicals = $

How do you Achieve Results?

- Good vendor, program administration, training, and oversight
- Right product for the application, proper testing frequencies
- Clear goals and metrics
- Automation
- Process to track deficiencies to resolution - accountability
- Data collection, tracking, reporting, **data visualization**
- Inspection, lab verification, corrosion monitoring
- Performance feedback/incentives to vendor
- Integrate these into your contract!
- Ongoing process improvement

Strategies

Implement automation to raise cycles of concentration:

- Conductivity controllers for cooling towers
  - Hi TDS limit – scaling on fill media
- Conductivity controllers for steam boilers
  - Hi TDS limit – foaming/carryover
  - Test conductivity of condensate

Strategies

Regular inspection and testing

- Daily/weekly/monthly onsite sampling/testing, written reports
- Install sample ports, coolers, pot feeders/filter feeders
- Quarterly lab testing of water samples
- Corrosion coupons – 90 day cycle
- Monitor dissolved iron and copper
- Side stream filtration
- Air/dirt separation
- Annual water side inspections and cleaning if needed

Strategies

Monitor equipment efficiencies:

- Chiller kW/ton, approach temperature
- Boiler combustion efficiency, fuel usage
- Hydronic system delta T
- Metered makeup water usage and blowdown
- Percent condensate return

Weekly Report – Test Results “Snapshot”

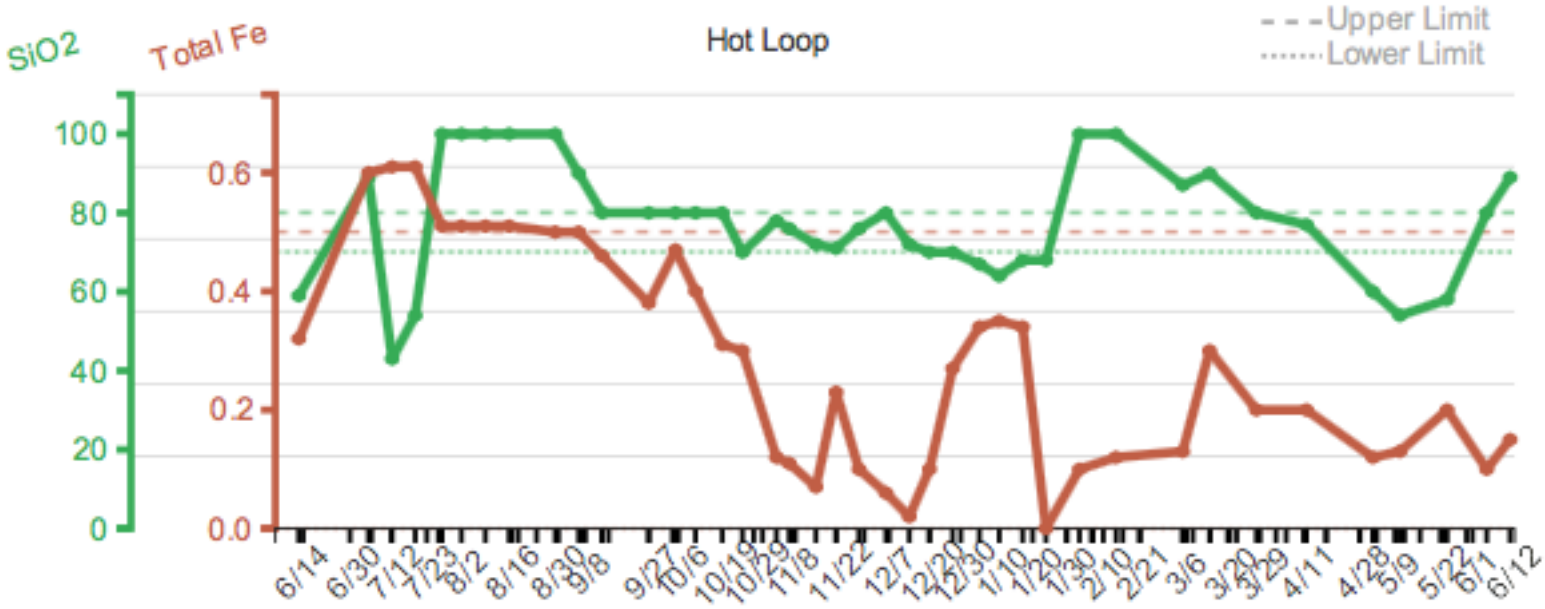
Results are in Parts per Million (ppm) unless otherwise indicated.

Water Sample	Central Plant Hot Loop	TH	Azole	SiO2	Total Fe	Total Cu	pH	Cond
	Hot Loop	2.0	2.0	89.0	0.15	0.1	8.8	520.0
Recommended Ranges		0	2	70	0	0	8.5	
		TO	TO	TO	TO	TO	TO	
		2	10	80	0.5	0.5	10.3	

Water Sample	TES	Azole	Mo	Total Cu	Diss Fe	pH	Cond
	Chill Loop	2.2	110.0	0.1	0.2	8.9	1000.0
Recommended Ranges		2	100	0	0	8.5	500
		TO	TO	TO	TO	TO	TO
		10	150	0.5	0.5	10.3	5000

Water Sample	Cooling Towers	TH	CaH	TAlk	Total Cl2	Bact CFU/mL	Azole	Total Cu	FT	pH	Cond
	Cooling Towers	900.0	600.0	550.0	1.0	500.0	2.1	0.2	110.0	8.3	1962.0
Recommended Ranges		0	0	0	0.5	0	2	0	100	8	1500
		TO	TO	TO	TO	TO	TO	TO	TO	TO	TO
		1000	600	1000	1	10000	10	1	150	9	2300

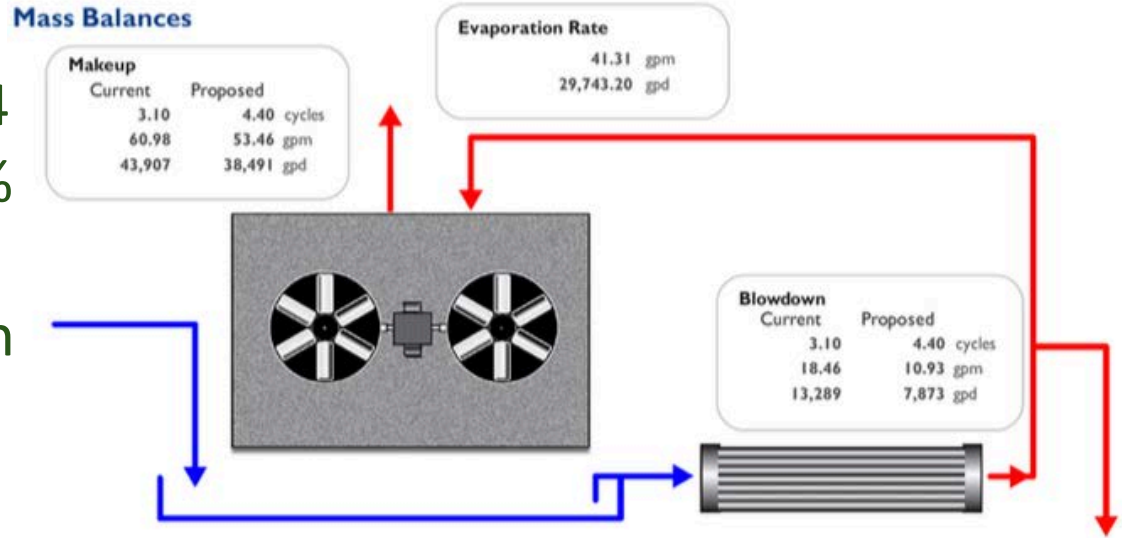
Weekly Report – Trend Graph w/Correlation



- Can see variations over time in relation to control limits
- Can see relationship between control (SiO2) and result (Fe)

Savings – Central Plant Cooling Towers

- Increased COC 3.1 to 4.4
- Reduced blowdown 41%
- Saving 2M gal/yr
- Saw marginal increase in soft white scale – easily removed



System Information	
Analyte Used	Conductivity
Analyte Concentration in Makeup	560.00
Analyte Concentration in Tower Current	1736.00
Analyte Concentration in Tower Proposed	2464.00
Temperature Drop Over Tower (°F)	10.0

Savings	Water(gal)	$
Makeup Water Savings/day	5,415	$57.72
Makeup Water Savings/year	1,976,631	$21,070.89
Sewer Discharge Savings/day	5,415	$35.74
Sewer Discharge Savings/year	1,976,631	$13,045.76
Total Annual Savings	1,976,631	$34,116.65

Savings – Central Plant Boilers

- Removed 1/32” CaCO3 scale
- Improved heat exchange eff 7%
- Saves 89,000 Th/yr
- Saves $35,600/yr

Scale on Surfaces

Scale Type	Soft Carbonate Scale
Scale Thickness	1/32"
Efficiency Reduction %	7.00%

System / Water Data

Boiler Steaming Rate (lb/hr):	10,350
Boiler Pressure, psig	55
Combustion Efficiency, %	80%
Makeup Water Temperature (˚F):	65
Feedwater Temperature (˚F):	90

Savings

Cost of Steam $/day	$1,393.12
Cost of Steam $/year	$508,492.10
Cost of Scale $/day	$97.51
Cost of Scale $/year	$35,594.44

Hours of Operation / Day:	24
Days of Operation / Year:	365
Fuel Type	Natural Gas
Fuel Unit of Measure	Therms
Cost per Unit	$0.40

Overall Results and Savings

- Water savings - 2,100,000 gal/yr
- Energy savings - 90,900 th/yr
- Utility budget savings - $72,900/yr
- Average corrosion rates 0.1 – 0.3 mil/yr (<0.5 excellent)

Links and Resources

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Questions?