Water Treatment of Central Air-conditioning Cooling System

Agenda

- Purpose of Water Treatment
- Difficulties of balancing among Corrosion, Scaling and Algae Control
- Treatment Theory (LSI)
- Successful Factor of Water Treatment
- Real-Time Water Treatment Automation System
- Q & A

Agenda

Purpose of Water Treatment

Purpose Of Water Treatment

"Water Treatment Plays a vital role in protecting the MEP asset as well as to increase system efficiency"

- *Prolong major equipment life-cycle by preventing breakdown or premature failure –* *equipment such as Cooling Tower, Chillers & Boiler*
- *Reduce any business risk/equipment downtime.*
- *Increase plant efficiency.*
- *Reduce environmental impact by optimizing water, energy and waste output.*
- *Reduce total cost of operation and repairs*

Water Treatment is an important part of your preventive maintenance in up keeping the MEP Assets.

Purpose of Water Treatment

Water Treatment Program is to mainly prevent,

- *Corrosion*
- *Scale*
- *Micro Bacteria*
- *Fouling*

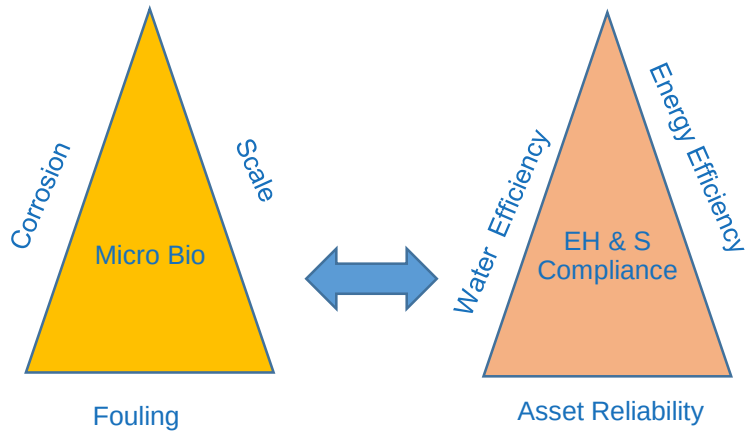
By this means,

Water Treatment Program enhance,

- *Asset Reliability*
- *Water & Energy Efficiency*

By eliminating wastages

- *EH & S Compliance*

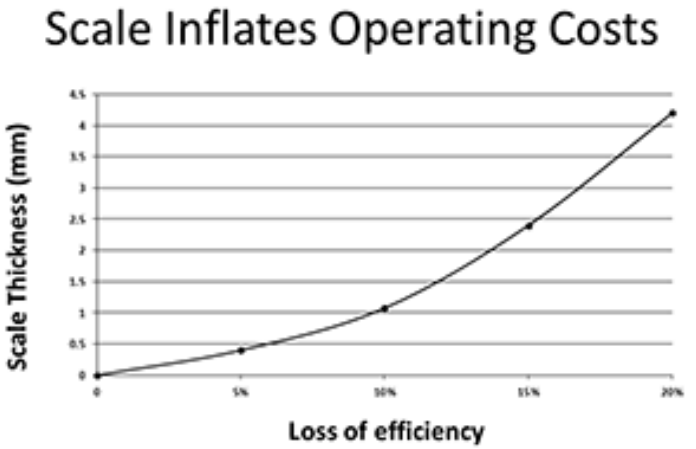


Agenda

Difficulties of Balancing among Corrosion, Scaling & Algae Control

Difficulties of Balancing Corrosion, Scale and Algae

- Impact of Scale
  - Every formation of the scales will reduce the efficiency of heat transfer thus is an increase of cost of operation.
  - The impact of scales on cost increment is exponential.



EQUIPMENT	KW/ TON	LOAD FACTOR	OPERATING HOURS	KWH/ RATE	ENERGY COST
500 TON CHILLER	x .65	x 100%	x 6,570	$ .09	= $192,173

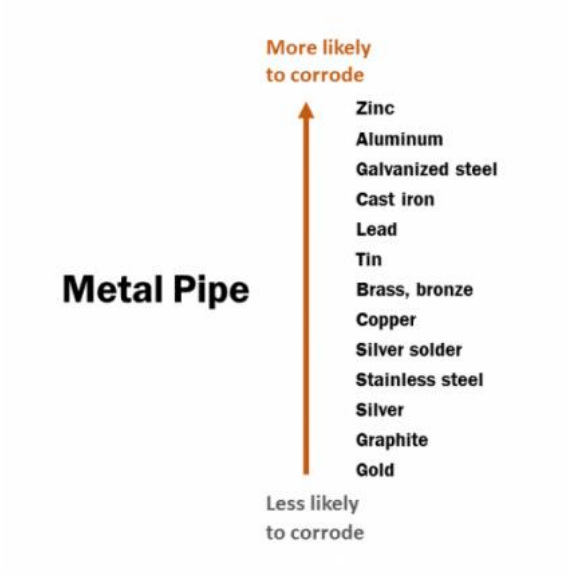
DEPOSIT THICKNESS (Inches)	% EFFICIENCY LOSS	INCREASED ENERGY COST
0.01	9%	$17,296
0.02	18%	$34,609
0.03	27%	$51,887
0.04	36%	$69,182
0.05	45%	$86,478

Just 1/32 of an inch of scale can add nearly $52,000 to the cost of operating a 500-ton chiller!

ENERGY SAVINGS 0.03" DEPOSIT	CHEMICAL CLEANING COST (EST.)	ANNUAL NET SAVINGS
$51,887	$900.00	= $50,987

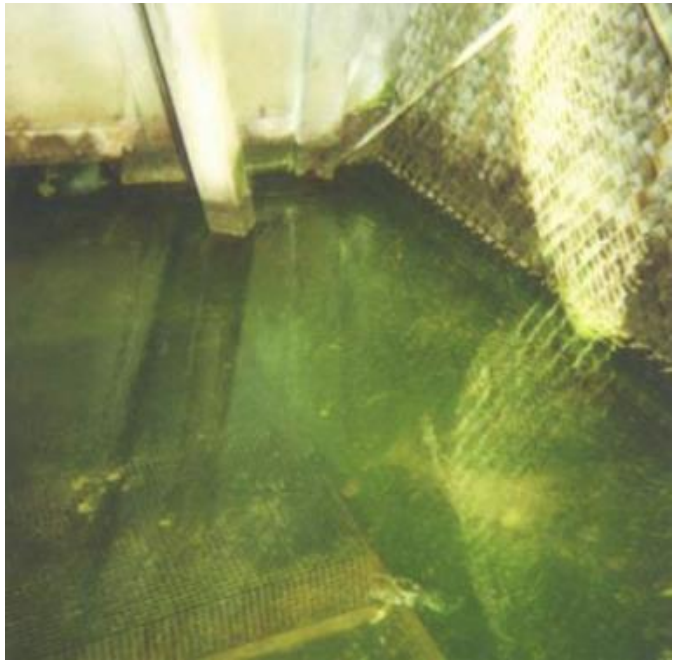
Difficulties of Balancing Corrosion, Scale and Algae

- Impact of Corrosion
  - Corrosion of the tube lead to inefficiency fluid flow and heat transfer thus increase in the cost of operation.
  - The impact of corrosion is irreversible. The only remedy to serious corrosion is only replacement of the part.



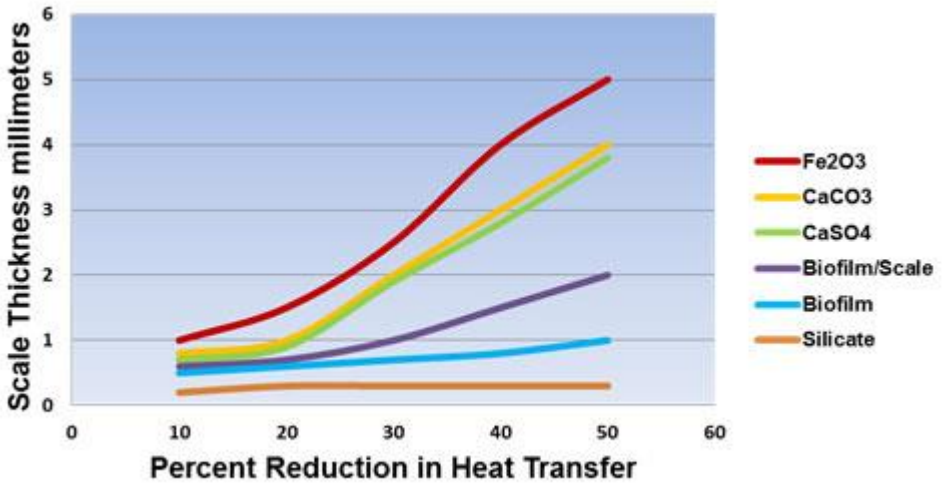
Difficulties of Balancing Corrosion, Scale and Alage

- Impact of Algae
  - Increases nutrient in cooling water
  - Increase mechanical cleaning
  - Increase bacteria like SPC, Legionella
  - Reduces water heat exchange



Difficulties of Balancing Corrosion, Scale and Algae

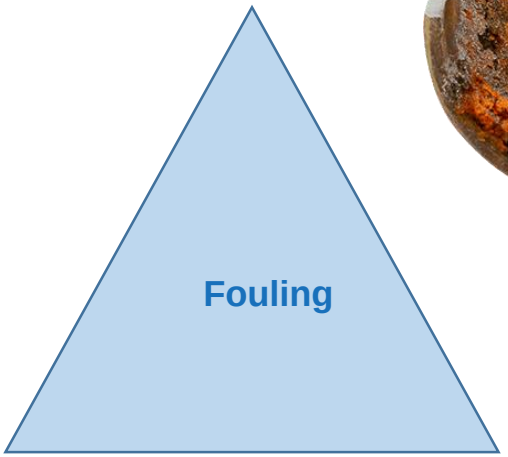
- Impact of Bio-Film
  - Bio-Film creates layer of organic insulation that reduce heat transfer efficiency.
  - The impact of bio-film on heat efficiency reduction is serious than most of the scale.
  - Bio-Film also increase the risk of Legionella outbreak.



Difficulties of Balancing Corrosion, Scale and Algae

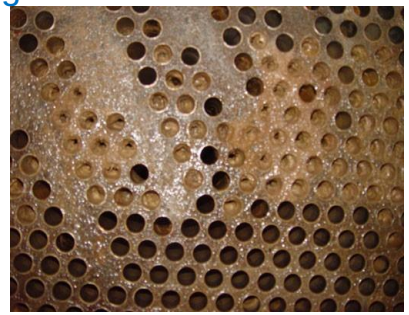
Water Balancing ?

Corrosion control



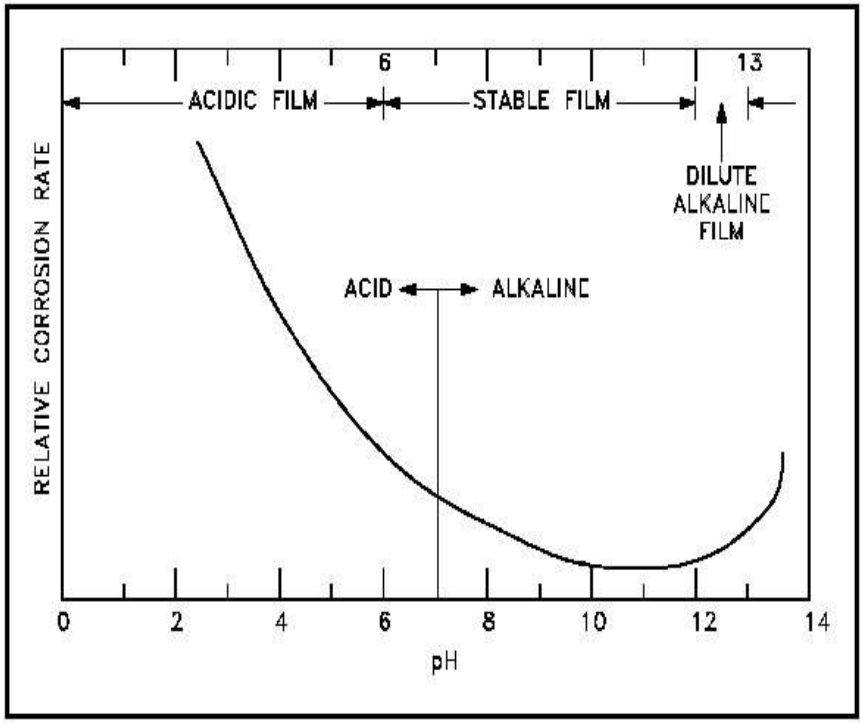
Algae control

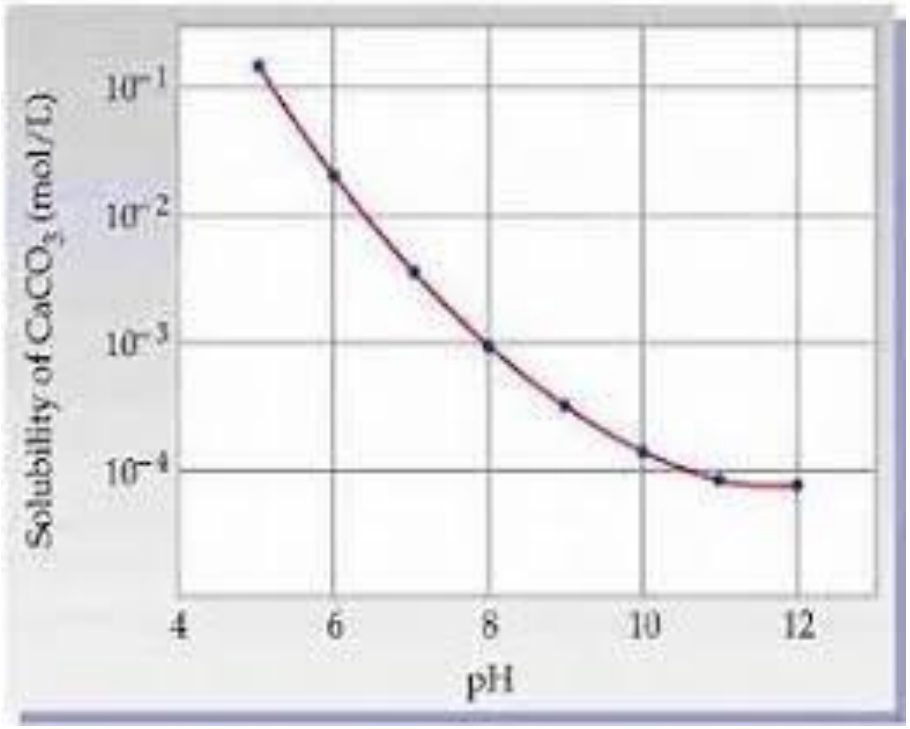
Scaling control



Difficulties of Balancing Corrosion, Scale and Algae

Water Balancing ?





High pH , low corrosion rate

High pH , High Scaling

Difficulties of Balancing Corrosion, Scale and Algae

What Influence all the above?

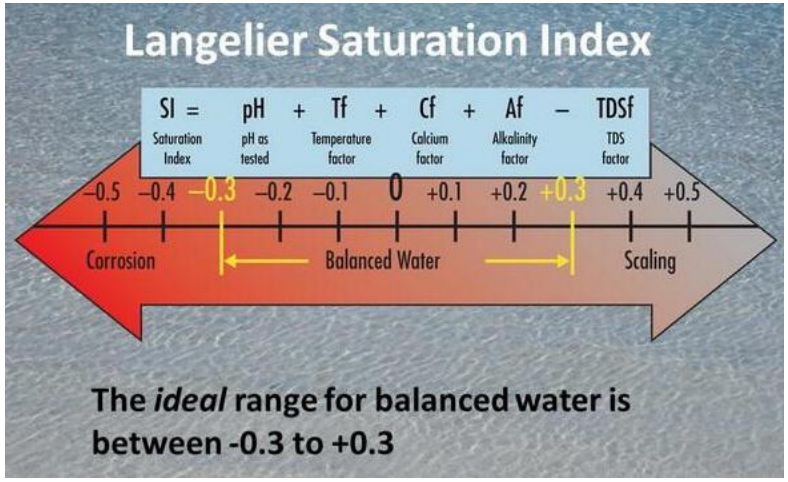
- Conductivity
- pH
- Alkalinity
- Hardness
- System Design & Operation (Temp, hrs , metallurgy)

Agenda

Treatment Theory (LSI)

Treatment Theory (LSI)

- What is LSI ?
  - Langelier Saturation Index (LSI)
  - Theorical concept of saturation water
  - Provides indicator of degree of saturation of water with respect to Calcium Carbonate.
  - It base on 10 logarithm of Calcite Saturation Level
  - Determine by pH equilibrium in the water



$$LSI = pH - pH_s$$

•Where:

- pH is the measured water pH
- pH_s is the pH at saturation in calcite or calcium carbonate and is defined as:

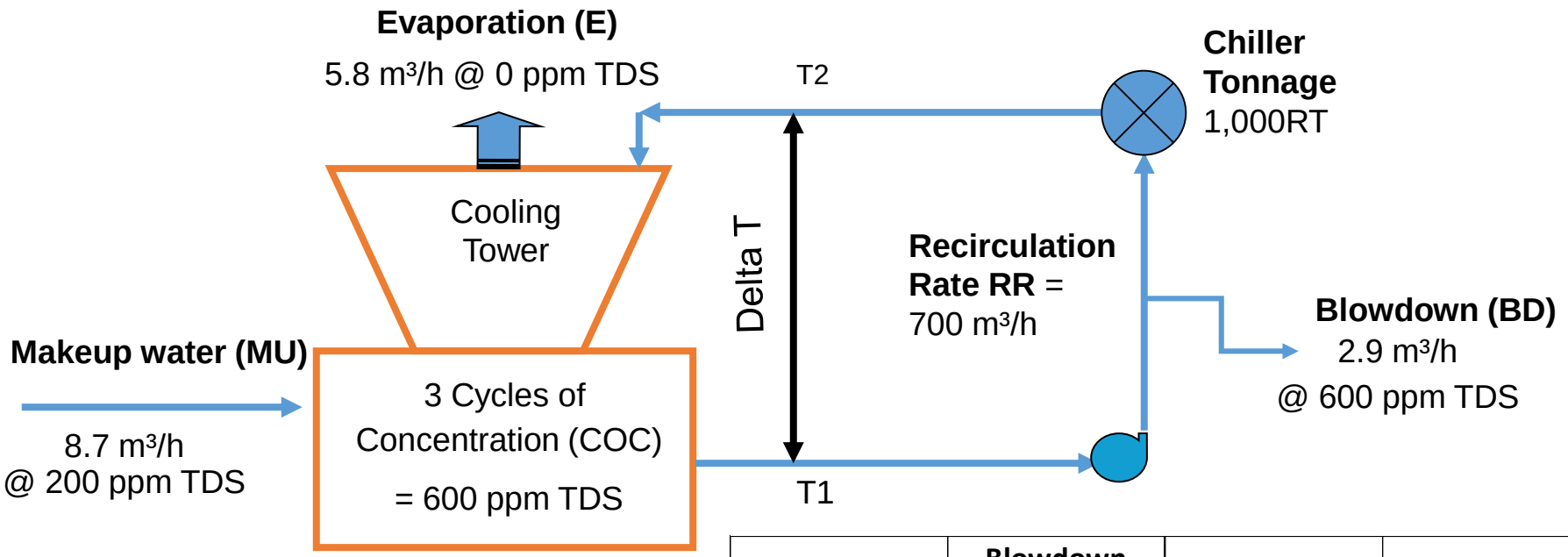
$$pH_s = (9.3 + A + B) - (C + D)$$

•Where:

- $A = (Log_{10}[TDS] - 1) / 10$
- $B = -13.12 \times Log_{10}(^{o}C + 273) + 34.55$
- $C = Log_{10}[Ca^{2+} \text{ as } CaCO_3] - 0.4$
- $D = Log_{10}[\text{alkalinity as } CaCO_3]$

•If LSI is negative: No potential to scale, the water will dissolve $CaCO_3$
•If LSI is positive: Scale can form and $CaCO_3$ precipitation may occur
•If LSI is close to zero: Borderline scale potential

Treatment Theory (LSI)

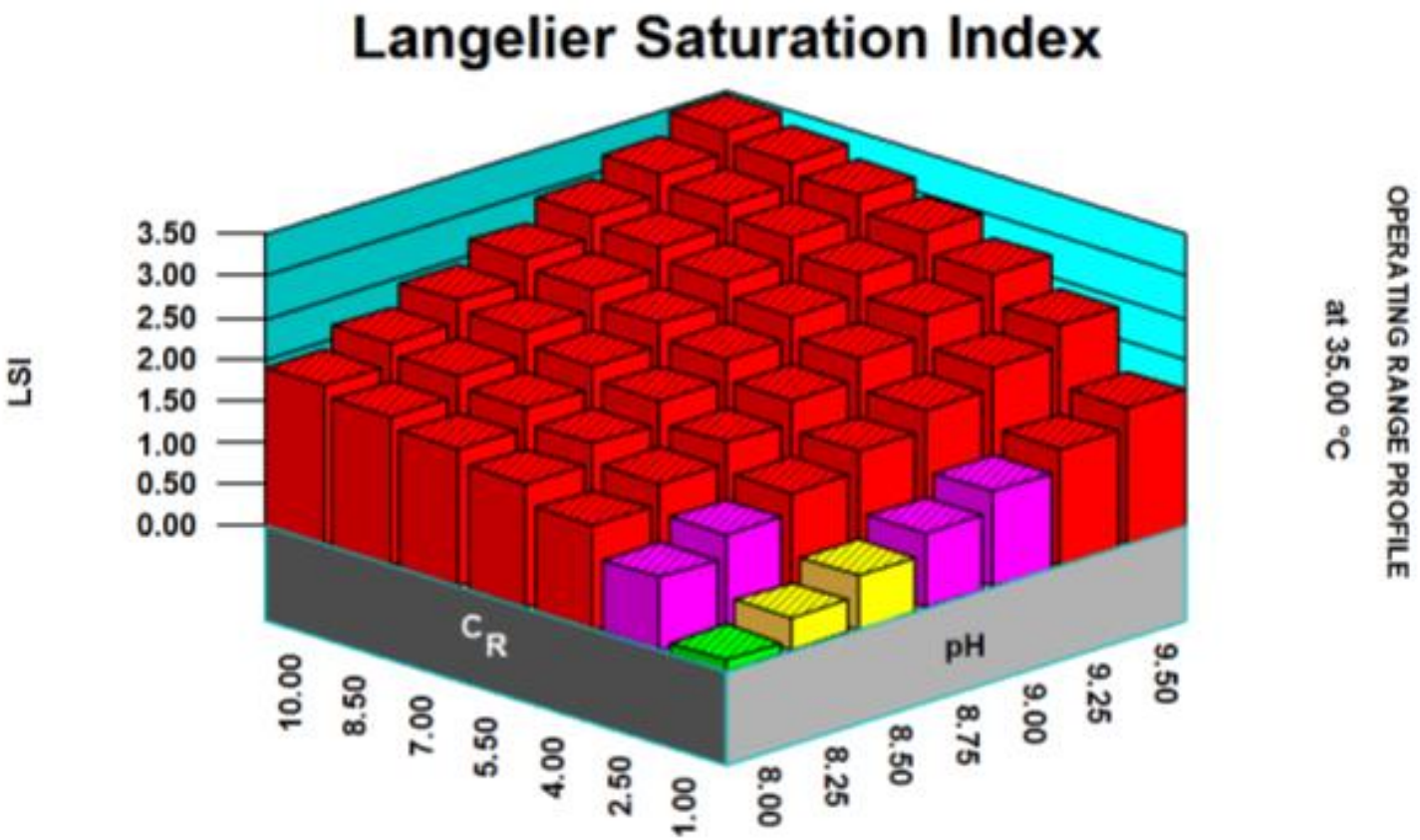


Mass Balance

MU = E + BD
CoC = MU/BD
Or,
= TDS_{BD}/TDS_{MU}

Cycles of Concentration	Blowdown Water m^3/h	Makeup Water m^3/h	Evaporation m^3/h
3	2.9	8.7	5.8
4	1.9	7.7	5.8
5	1.4	7.2	5.8
6	1.2	6.9	5.8
7	1.0	6.8	5.8
8	0.8	6.6	5.8
9	0.7	6.5	5.8
10	0.6	6.4	5.8

Treatment Theory (LSI)

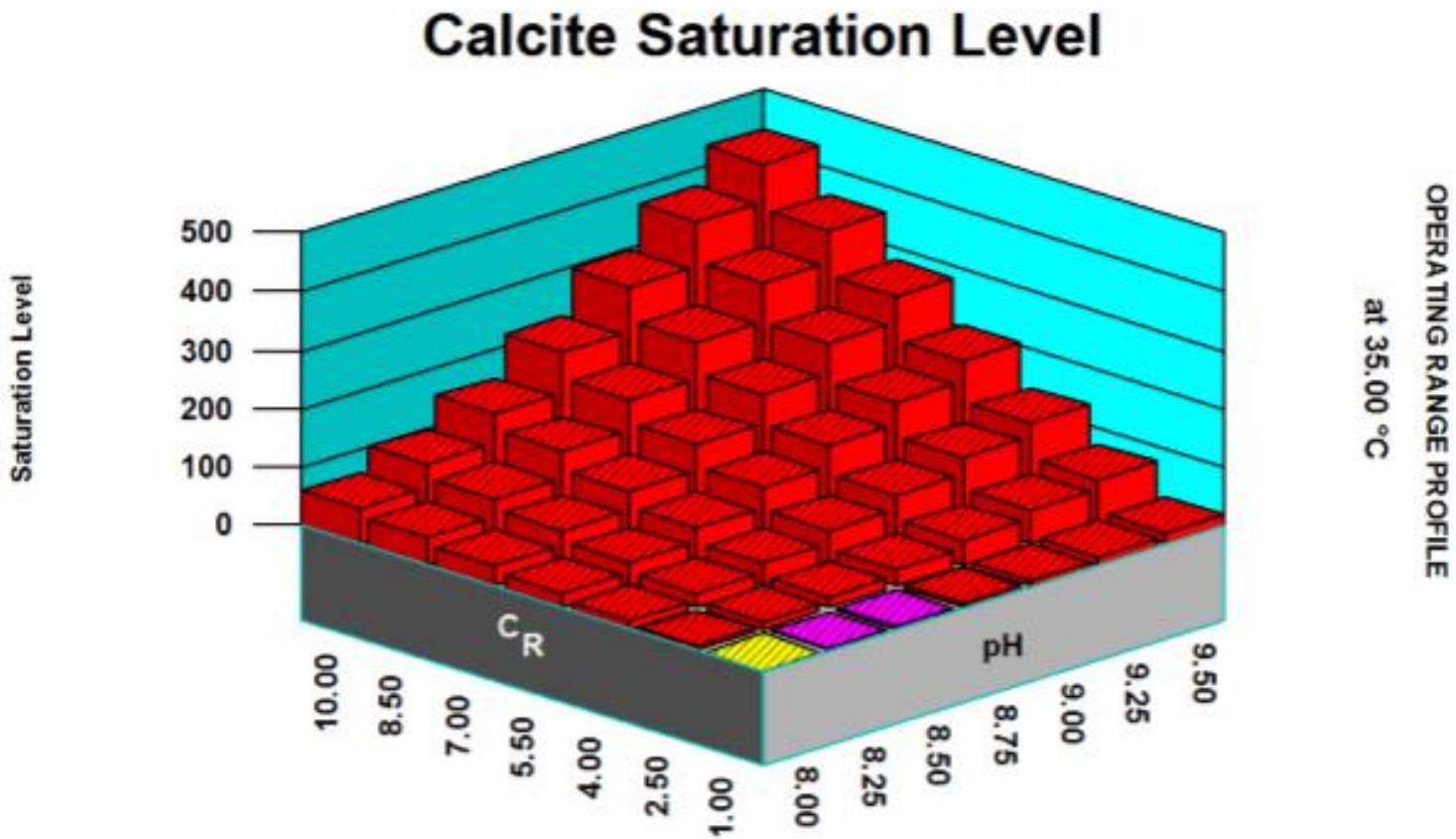


** It shown that, pH higher 8, cycle higher 4, at 35 deg. C of cooling tower water, very high tendency to scale**

Langelier Saturation Index : Most common scaling predicting index

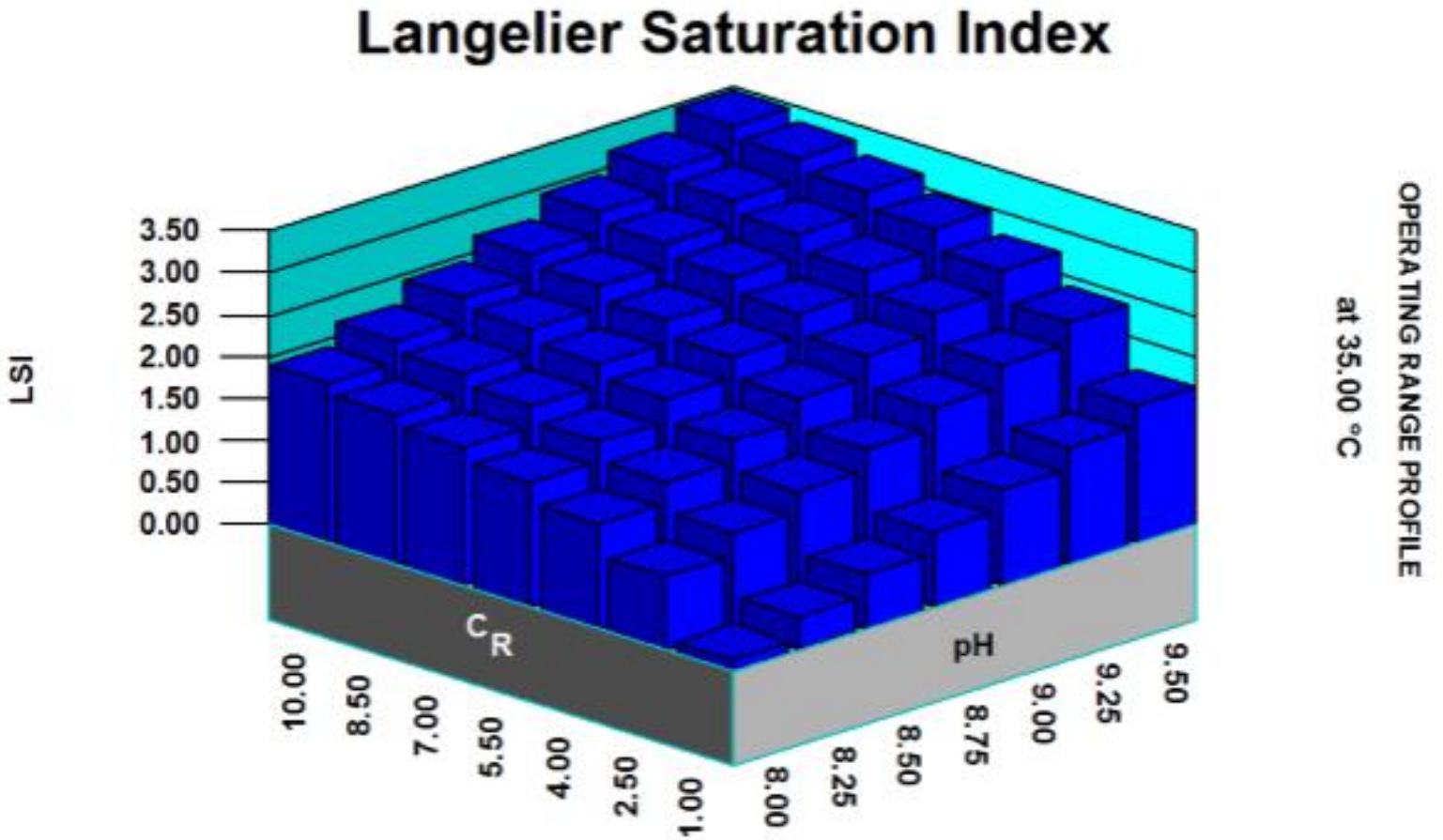
Treatment Theory (LSI)

Also, the below is the calcium carbonate scaling tendency chart under different pH and CR (cycle of recirculation).



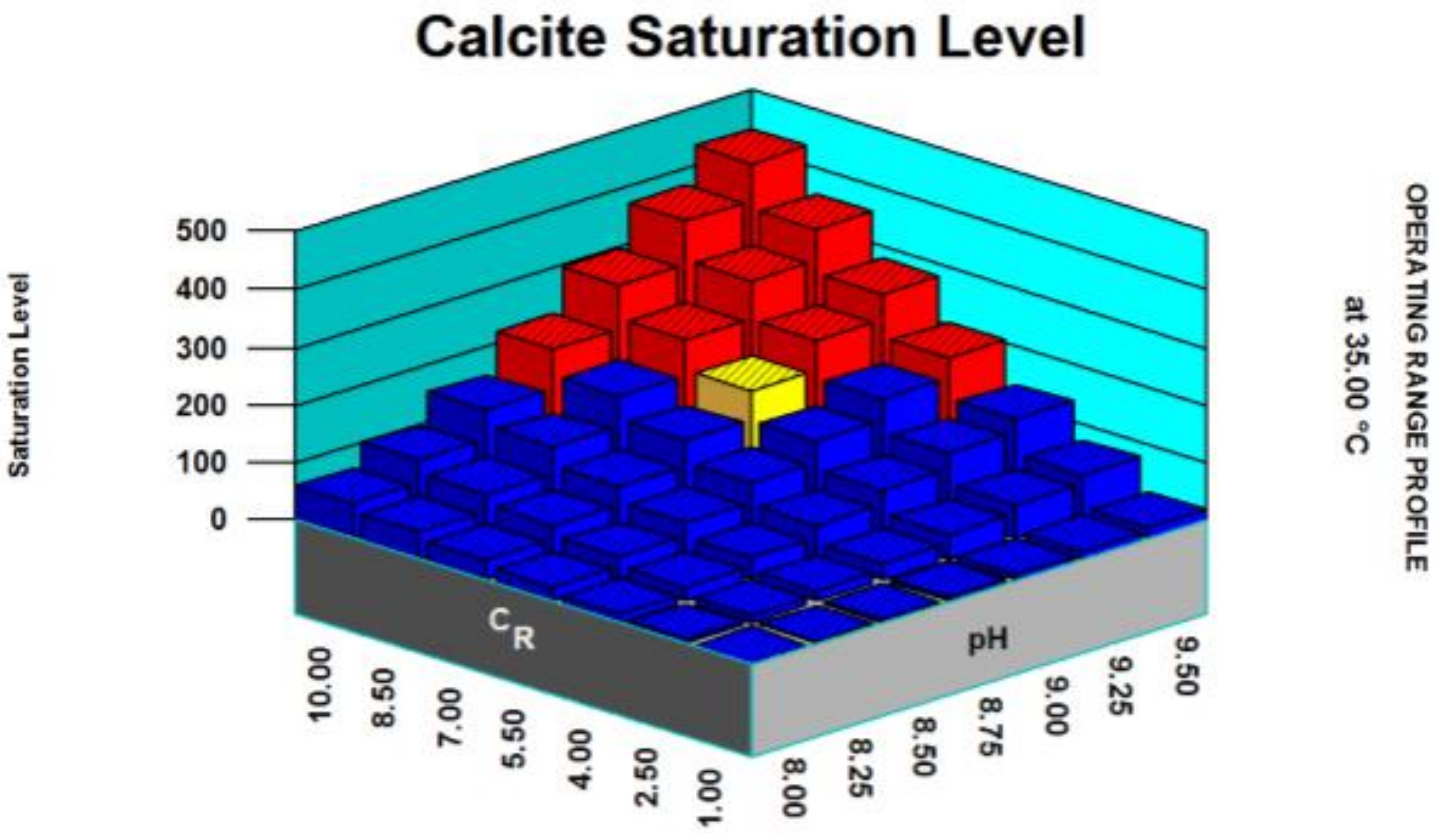
Treatment Theory (LSI)

- After that, we dose 100ppm Chem-aqua 31155, and provide pH control between +/- 0.1 of 8.2.



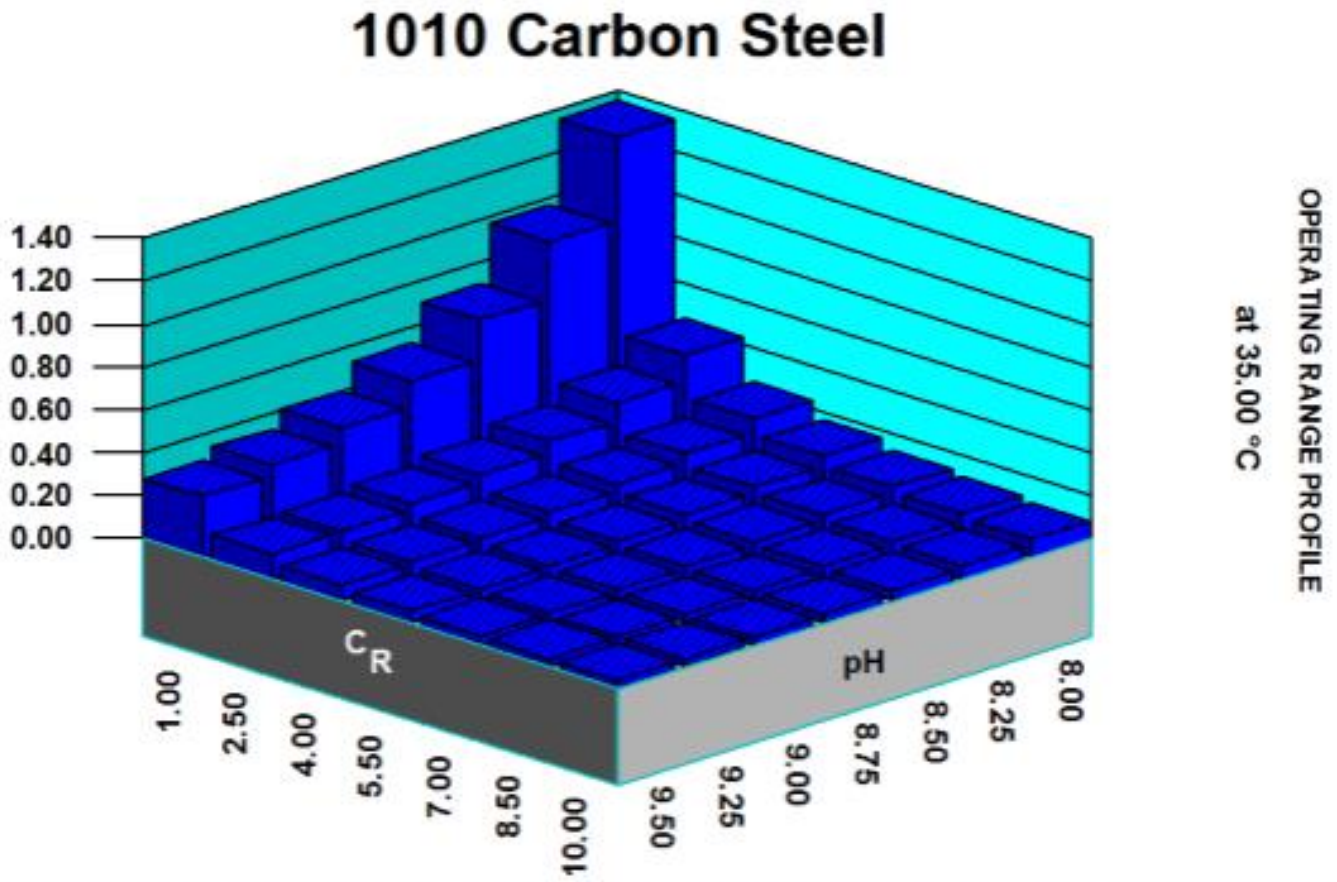
Treatment Theory (LSI)

And, the corrosion rate of carbon steel and calcium carbonate scaling tendency estimated scenario as below:



<< For pH 8.2: +/- 0.1 and Cycle kept at 8, scaling tendency is very low >>

Treatment Theory (LSI)



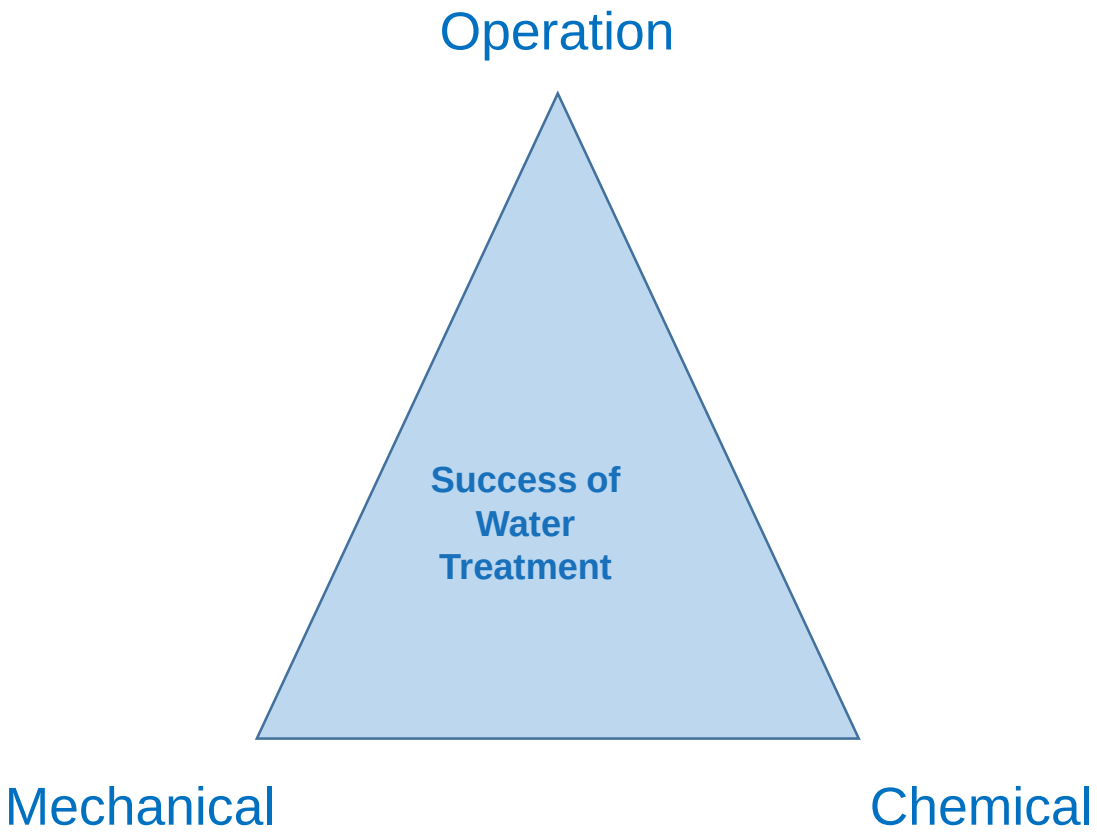
<< with dose CA31155, estimated carbon steel corrosion rate is only 0.1 or 0.2 MPY >>

Agenda

Successful Factor of Water Treatment

Successful Factor of Water Treatment - Summary

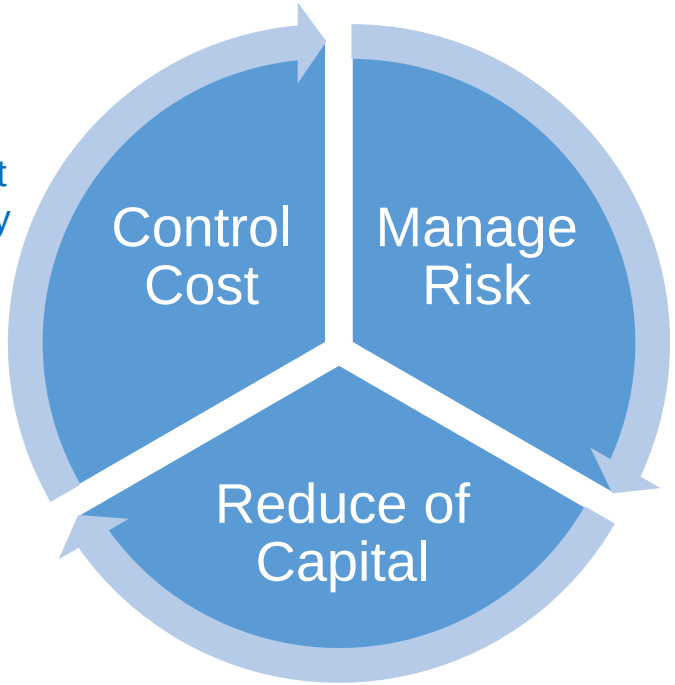
“MOC” Approached



Successful Factor of Water Treatment - Summary

Effective Water Treatment

- Reduce maintenance/breakdown cost
- Improve operation efficiency
- Decrease Water & Energy consumption
- Optimization of chemical usages



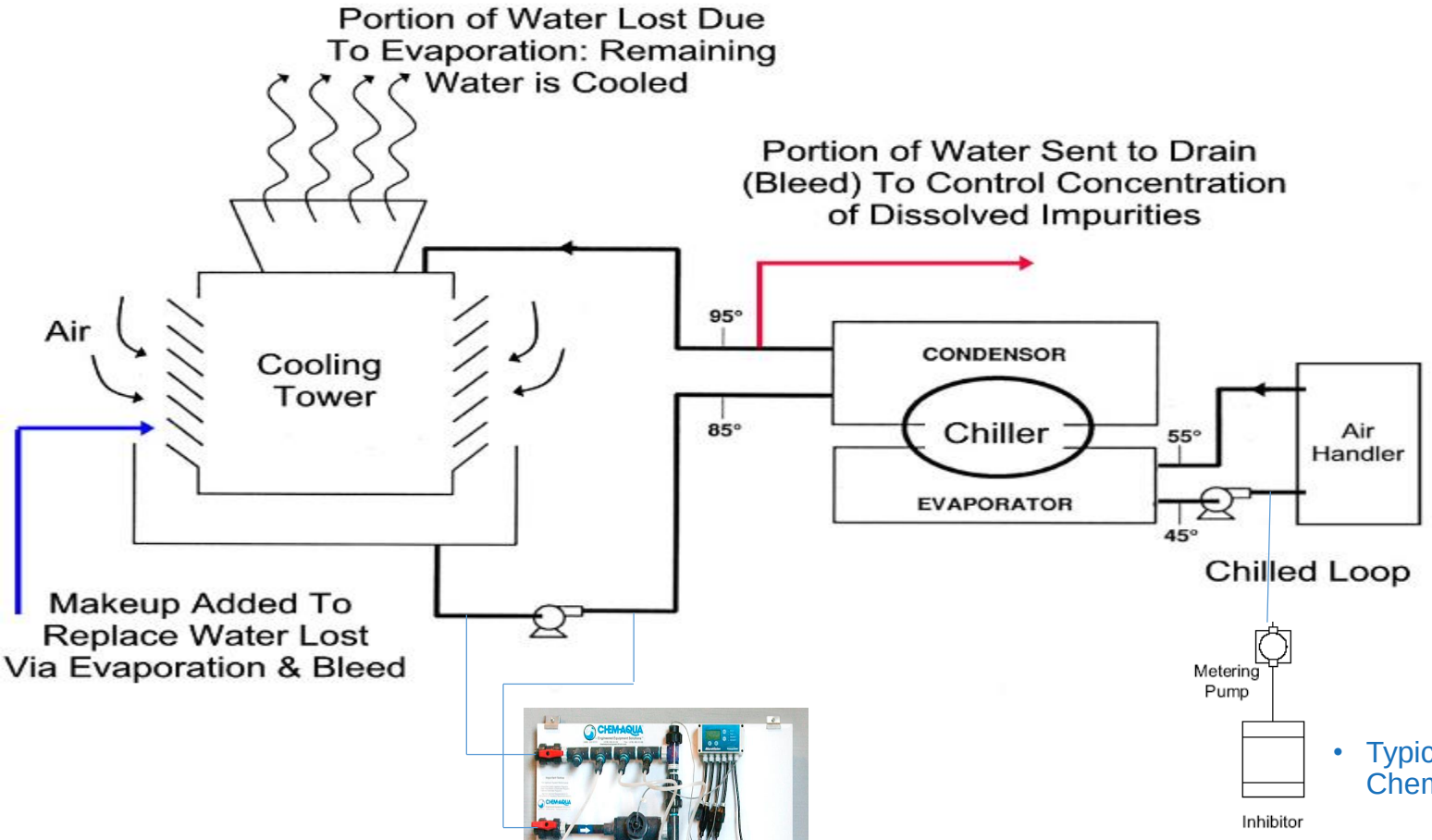
- Ensure operating reliability by preventing business risk
- Avoid EH & S fines and any legal issues

- Avoid premature failures/equipment replacement
- Extend equipment life

Agenda

Real-time Water Treatment Automation System

Real- time Water Treatment Automation System



- Typical Condenser Water Chemical Dosing System

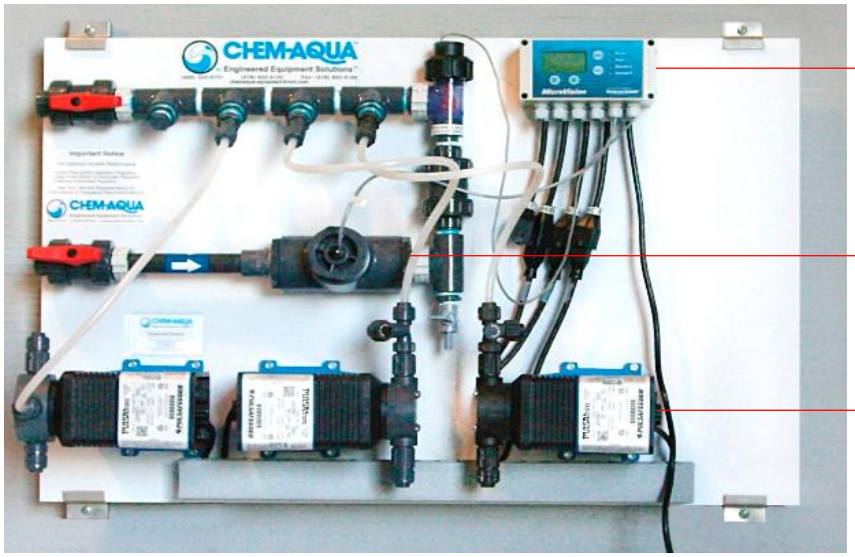
- Typical Chilled water Chemical Dosing

Real- time Water Treatment Automation System

Conventional Water Treatment Automation System

CWR

CWS



Conductivity Controller c/w conductivity real time display

Conductivity Sensor

Dosing Pump each interlock with timer

Biocide 1

Biocide 2

Corrosion/ Scale Inhibitor

Real- time Water Treatment Automation System

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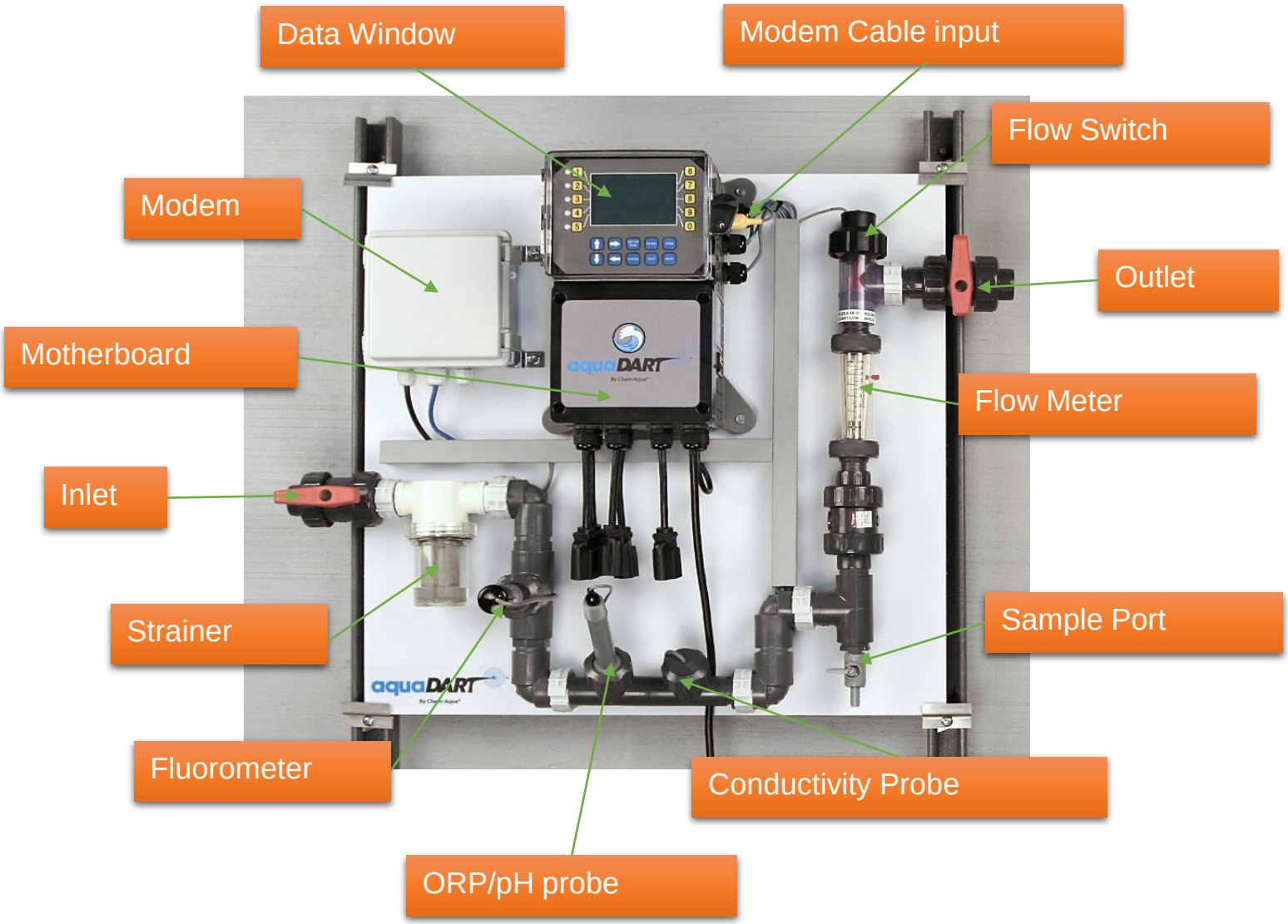
Real-Time Water Treatment Automation System

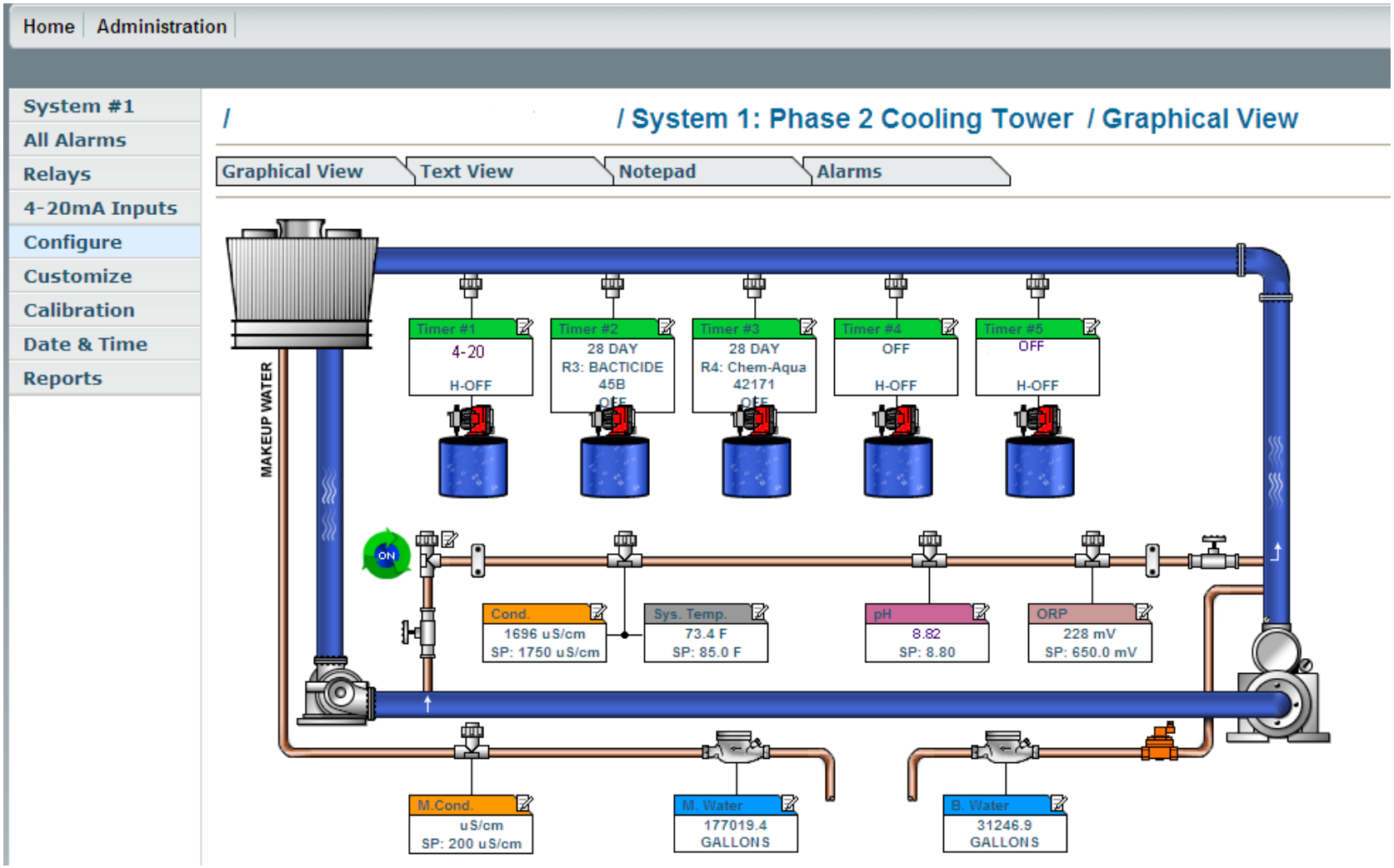


Real- time Water Treatment Automation System

Web Base Communications

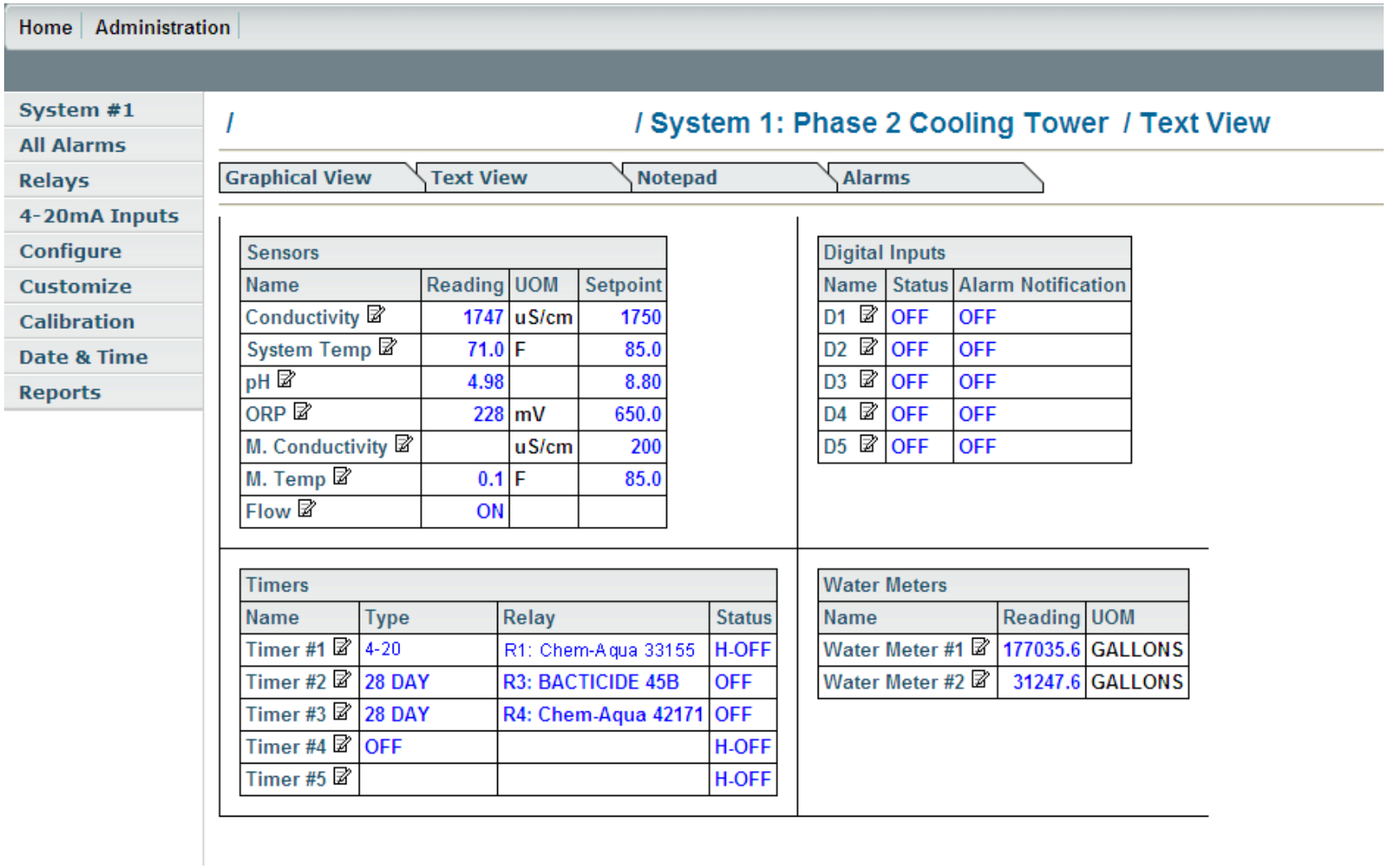
Real- time Water Treatment Automation System

Web Base Interface



Real- time Water Treatment Automation System

Web Base Interface



Agenda - Summary

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Proper Water Treatment Program – Overall Outcome

Water Reduction

Energy Reduction

Waste Reduction

Asset Protection

Productivity Improvement

Safety Improvement

Total Cost of Operation Savings

Profitability Improvement

Water Treatment of Central Air-conditioning Cooling System

THANK YOU