This presentation premiered at WaterSmart Innovations

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INNOVATIONS

WATER CONSERVATION IN COOLING TOWERS USING CONTROLLED HYDRODYNAMIC CAVITATION

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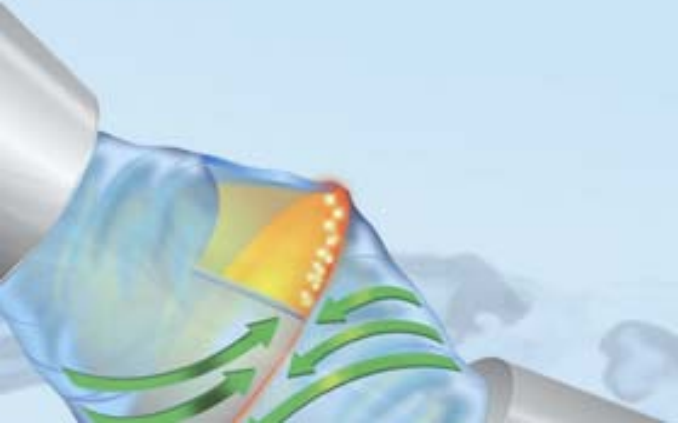

VRTX
ADVANCED FLUID TECHNOLOGY
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Topics for Discussion

- **Cooling Water Issues**
- **Technology Options (non chemical)**
- **Case Histories**
- **Summary**
- **Questions**

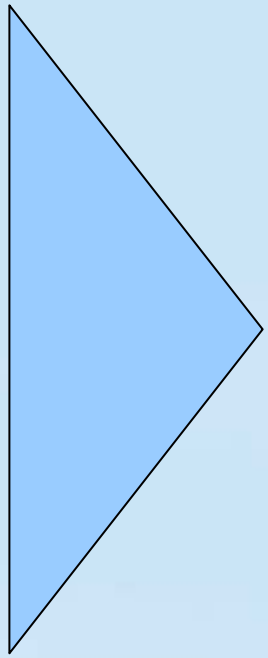
Cooling Water Applications

Cooling Tower

Evaporative Condenser

Problems Related to Cooling Water Treatment

PROBLEMS
Scale
Corrosion
Bacteria



EFFECTS

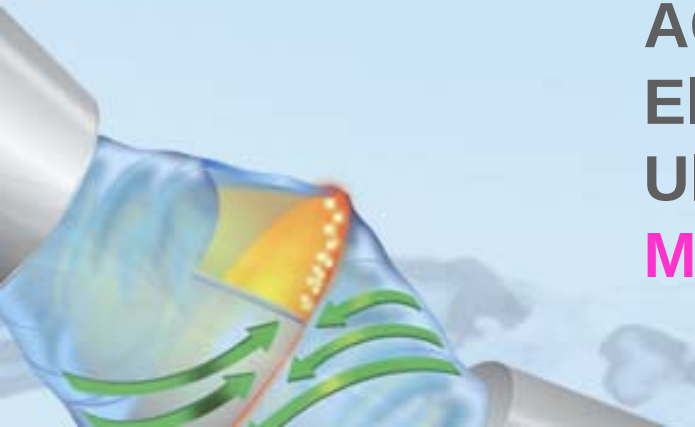
- Increased maintenance cost
- Reduced heat transfer efficiency
- Increased energy cost
- Increased water costs
- Increased sewage costs
- Increased safety and training issues
- Reduced plant efficiency
- Reduced equipment life
- Growth of hazardous micro organisms

NON-CHEMICAL WATER TREATMENT

Non-chemical devices (NCDs) use many different technologies to achieve scale, corrosion and biological control.

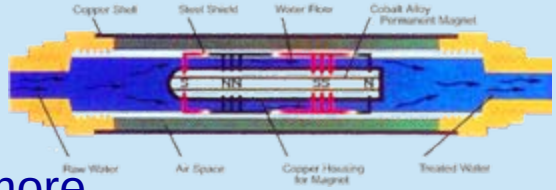
Over 30 suppliers are known to provide commercially available products that can be grouped into five basic classes or methodologies

Magnetic
AC Induction
Electrostatic
Ultrasonic
Mechanical Energy (CHC)
(Controlled Hydrodynamic Cavitation)



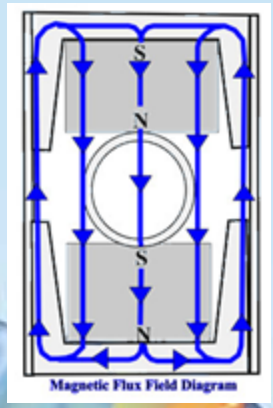
NON-CHEMICAL WATER TREATMENT

Magnetic



These devices generally have one or more permanent magnets mounted either to the outside or inside of a pipe containing the water to be treated.

Magnetic devices act through the Lorenz force (charged particles moving through a magnetic field) that reportedly influence ions in the water to prevent scale.



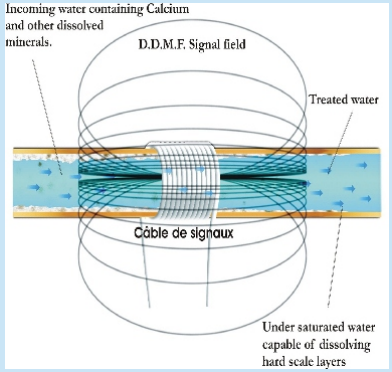
Magnetic Flux Field Diagram

The crystal growth of scaling minerals is promoted within the fluid (controlled precipitation). These grown crystals remain suspended in the solution.

Scale control

NON-CHEMICAL WATER TREATMENT

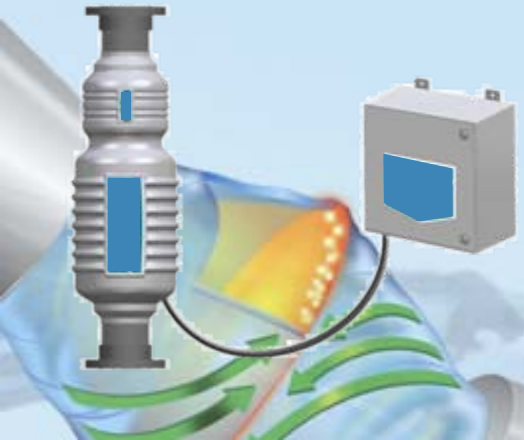
AC Induction



Consist of induction coils rapped around a pipe or as a stand alone unit containing the coils that are then placed into the cooling water flow.

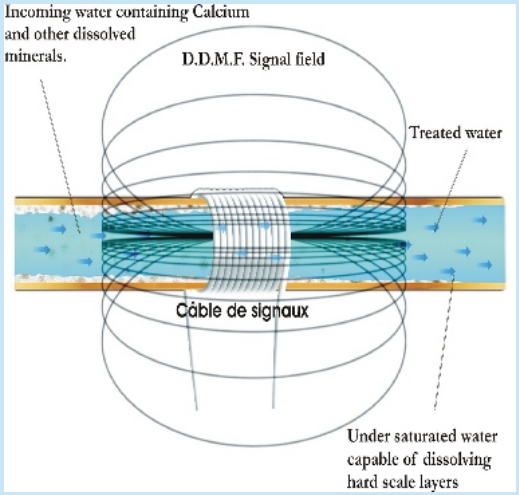
An alternating current is sent through the coils resulting in an induced electric field along with variable magnetic fields imparted to the water.

The crystal growth of scaling minerals is promoted within the fluid (controlled precipitation). These grown crystals remain suspended in the solution.



Scale, corrosion, biological control

NON-CHEMICAL WATER TREATMENT



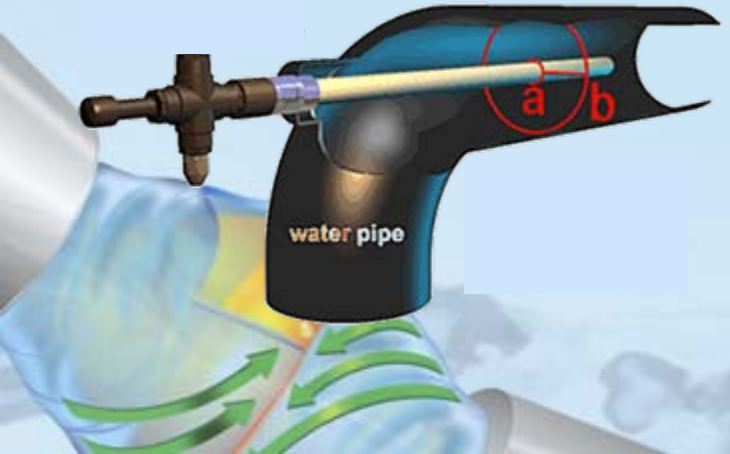
Electrostatic

Designed to generate the powerful electric field

Induced electric field inside the fluid which affects the electrically charged, dissolved ions of scale-causing minerals.

The crystal growth of scaling minerals is promoted within the fluid (controlled precipitation). These grown crystals remain suspended in the solution.

Scale, biological control

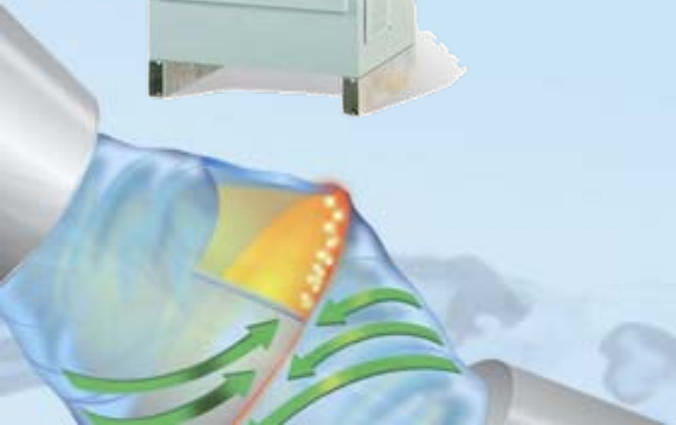


NON-CHEMICAL WATER TREATMENT

Ultrasonic

Ultrasonic waves are generated using high power, high intensity ultrasonic transducers. As the sound waves pass though the water to be treated, the water is alternatively compressed and decompressed with the potential for cavitation to result

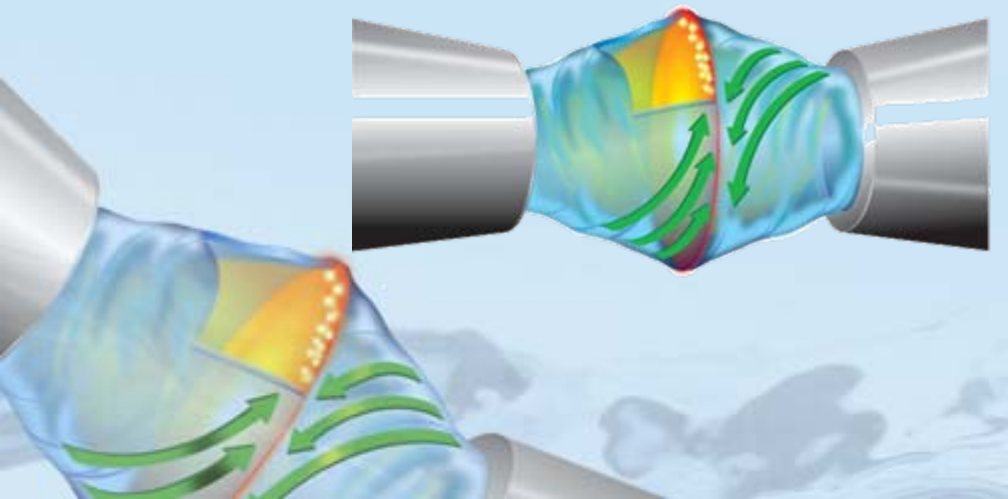
Primarily used for biological control



NON-CHEMICAL WATER TREATMENT

Mechanical Energy

Uses pressure pumps to force water into plates, walls, or other water streams with the intent on producing Controlled Hydrodynamic Cavitation (CHC).



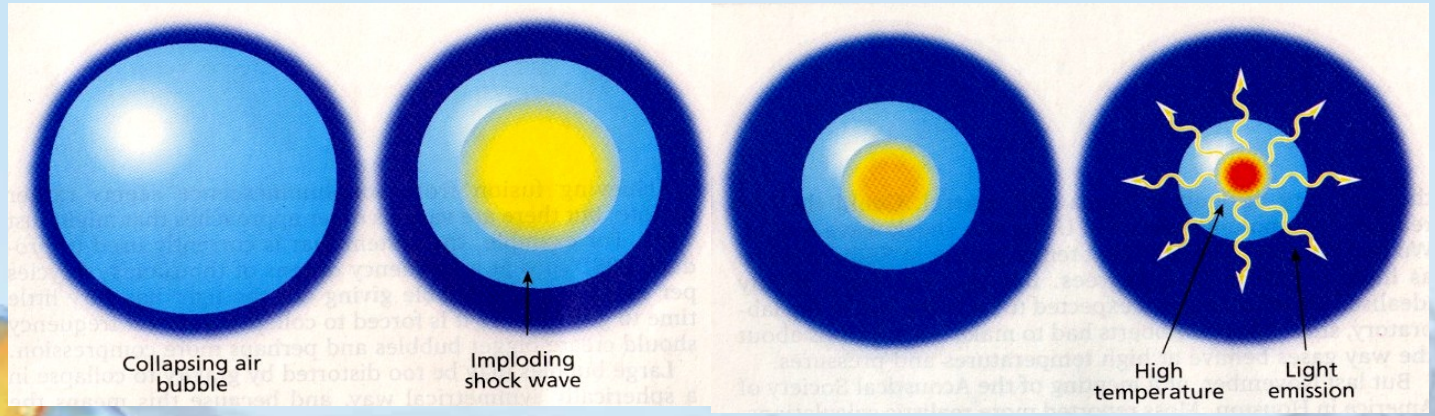
What is Cavitation

Cavitation is the dynamic process of the formation, growth, and collapse of micro-sized bubbles in a fluid. During bubble collapse, extremely high temperature and intensive pressure waves are generated around the bubbles. Controlled hydrodynamic cavitation (CHC) is a process that seeks to optimally produce cavitation and harness the kinetic energy that is imparted to the fluid.

Fundamentals of Cavitation

What Happens When Bubble Collapse?

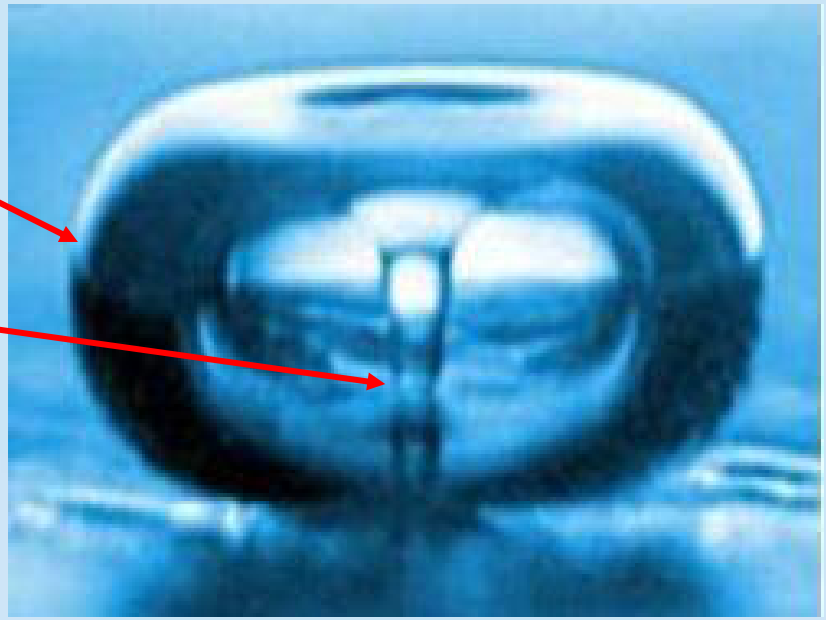
- Create intensive shocking wave (sound)
- Produce extremely high localized temperature (10-17,000° F) and pressures (12-150,000 psi)



Fundamentals of Cavitation

Collapsing Bubble

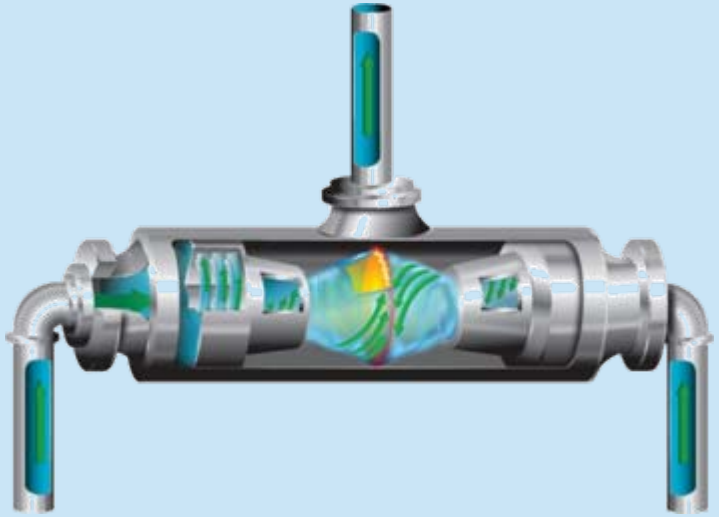
A Microjet with Velocities Approaching 250 MPH

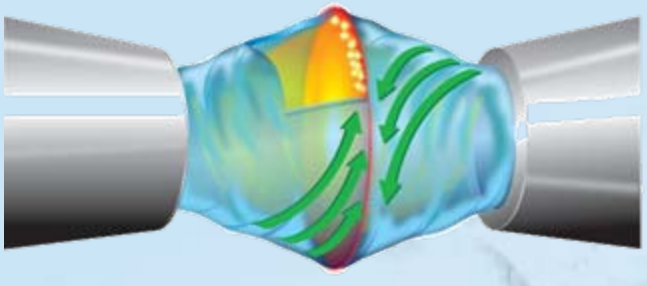


Propeller damage due to cavitation

CHC Technology: How It Works

- *CHC chamber consists of a pressure equalizing chamber and a cavitation chamber*
- *Water is pumped into pressure equalizing chamber, then channeled into the cavitation chamber where it is forced to rotate at high velocity through precision nozzles*
- *Rotating water streams create a strong vacuum*
- *Micro bubbles form and grow at the nozzle exit*
- *The bubbles collapse catastrophically (cavitation) within the cavitation chamber*
- *The opposing streams collide at the mid-point of the chamber creating high shear forces*

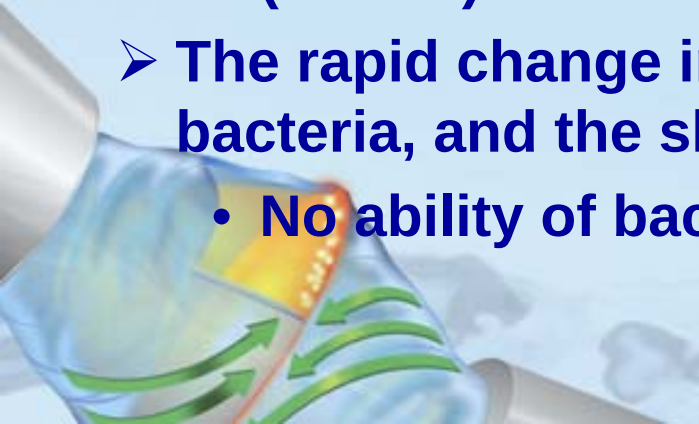




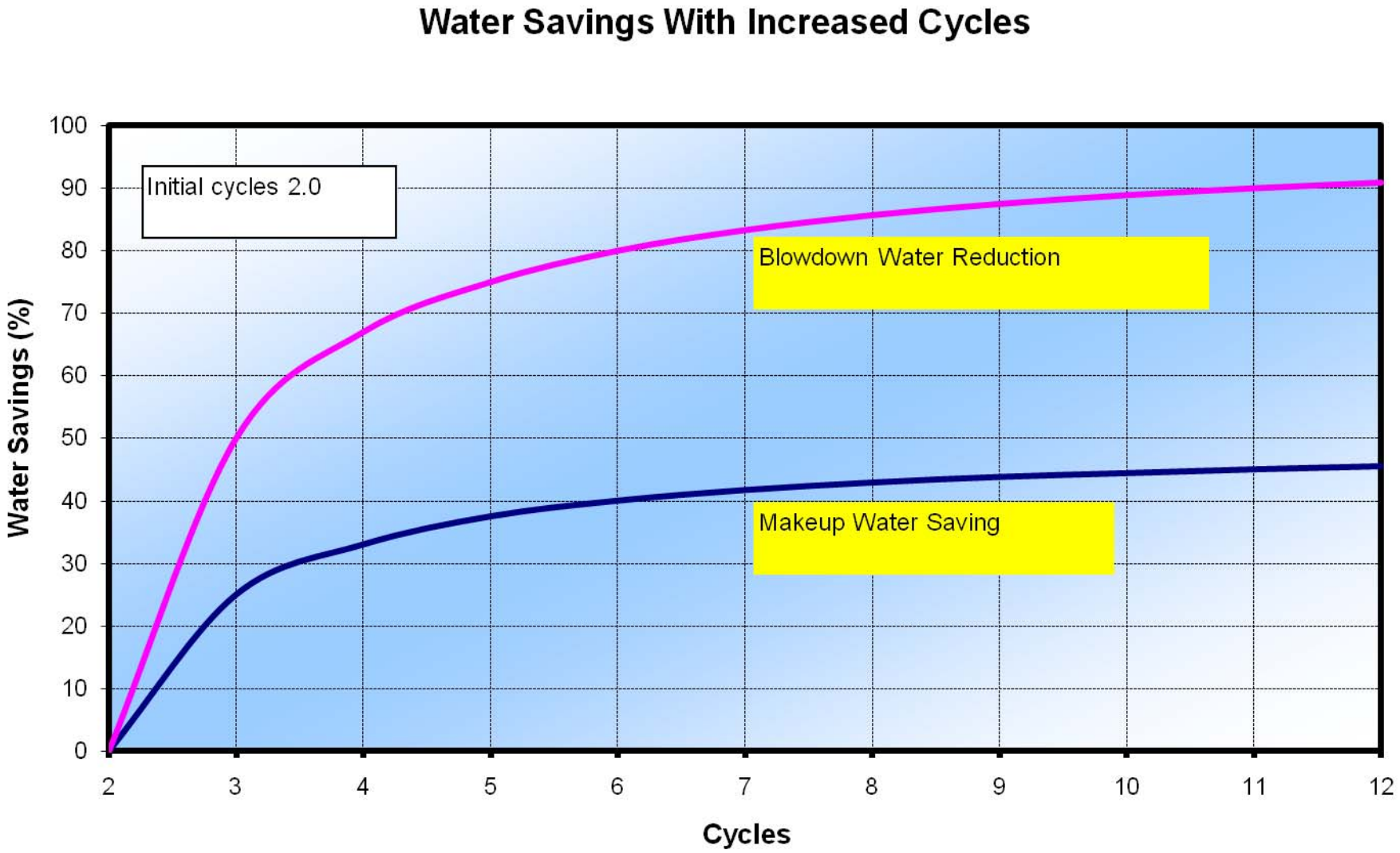
CHC Technology: **How It Works**

Effects on Cooling Water

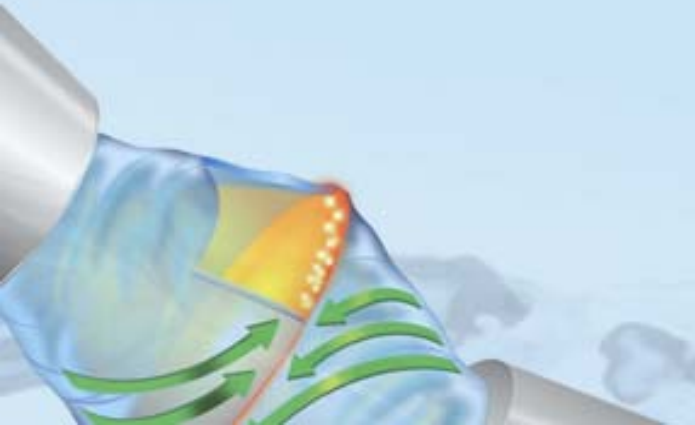
- **$CaCO_3$ (calcium carbonate or scale) is precipitated out.**
  - **This "seed" crystal agglomerates with similar crystals, and becomes a nucleation site for calcium and bi-carbonate ions.**
  - **Filtration is used to remove the scale particle from the water.**
- **The vacuum degasses some CO_2 from the water.**
  - **This buffers the pH of the water to a non-corrosive level (8.2-9.2).**
- **The rapid change in pressure ruptures the cell walls of bacteria, and the shear forces further breaks them apart.**
  - **No ability of bacteria to form resistance to cell disruption.**



What Increasing Cycles Of Concentration Can Do For You



CASE STUDIES

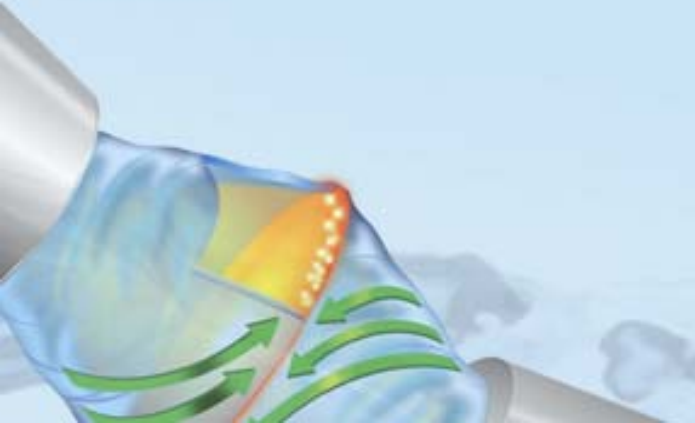


CASE HISTORY 1:

Cooling Tower Water Savings: CHC vs. Chemical

Background

Location	**Southern NV**
Unit size	**350 ton**
Flow rate	**1050 gpm**
System volume	**1462 gal**
Usage	**3720 hr/yr**

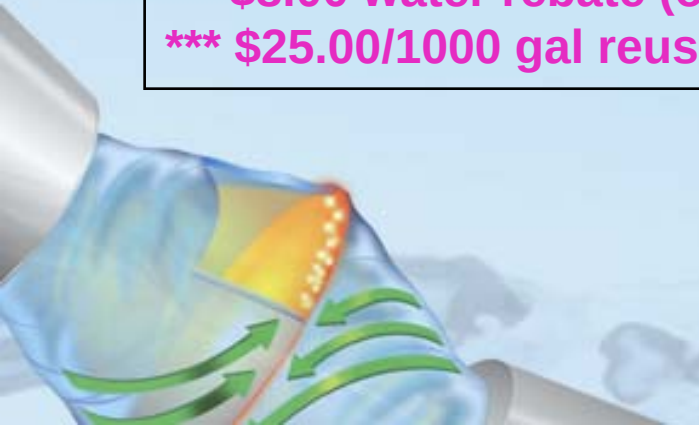


CASE HISTORY 1:

Water Savings: CHC vs. Chemical

Treatment	Cycles	Make-up gal	Savings gal	Savings $
Chemical	2	2,355,318	na	na
VRTX	3	1,769,418	585,900	1,529* 4,688** 2,925***

* $1.46-3.46/1000 gal make-up water (per yr)
* $1.71/1000 gal sewer charge (per yr)
** $8.00 water rebate (one time)
*** $25.00/1000 gal reuse credit, assume 1/5 recycle vol (per yr)



CASE STUDY 2: BREWERY

CUSTOMER ISSUE

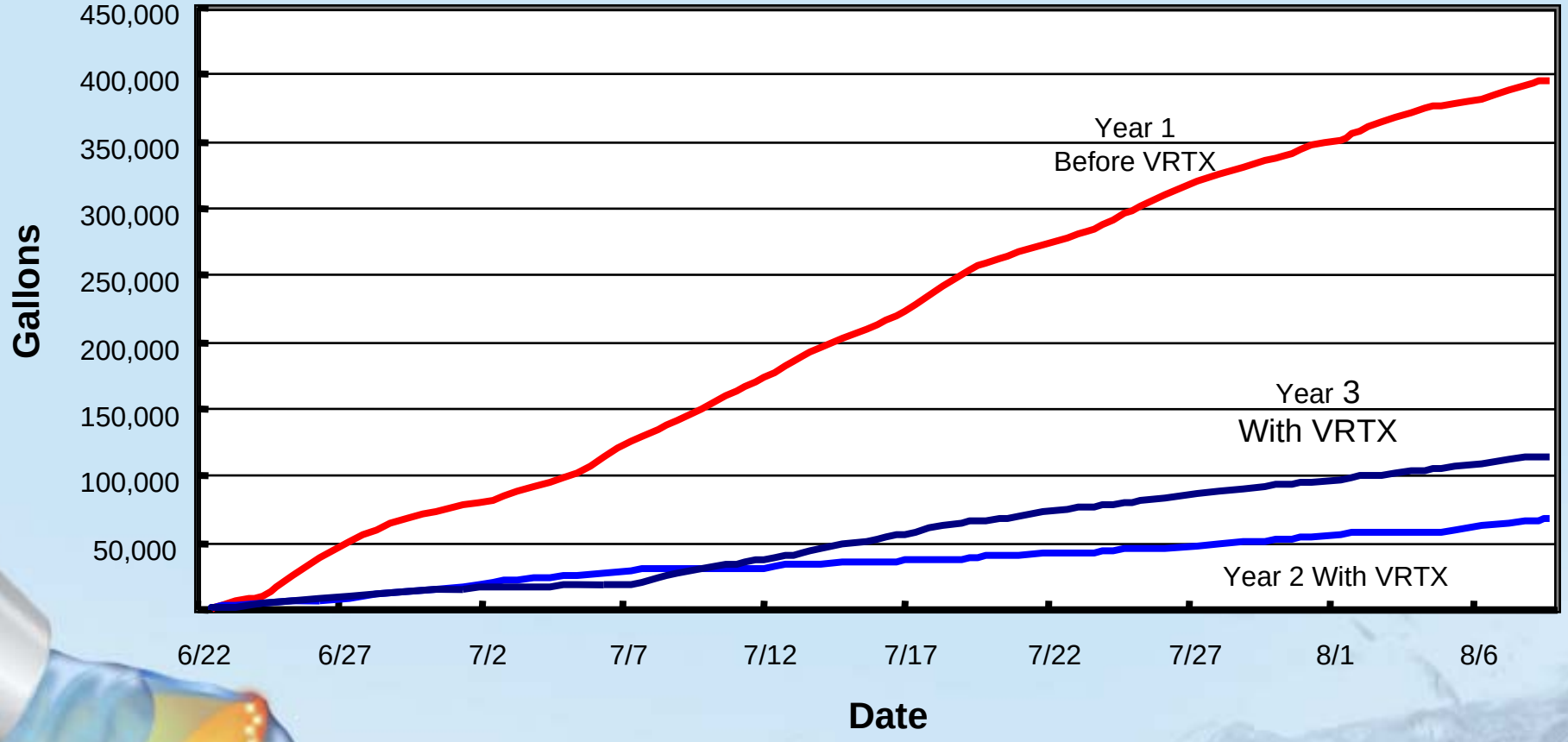
A brewery operates a refrigeration system and averaged 2.0 cycles of concentration on chemical treatment. Significant scale deposits accumulated around the condenser tubes and inside the condensers.

SOLUTION

A 60-GPM VRTX system and filtration was installed in August 2001.

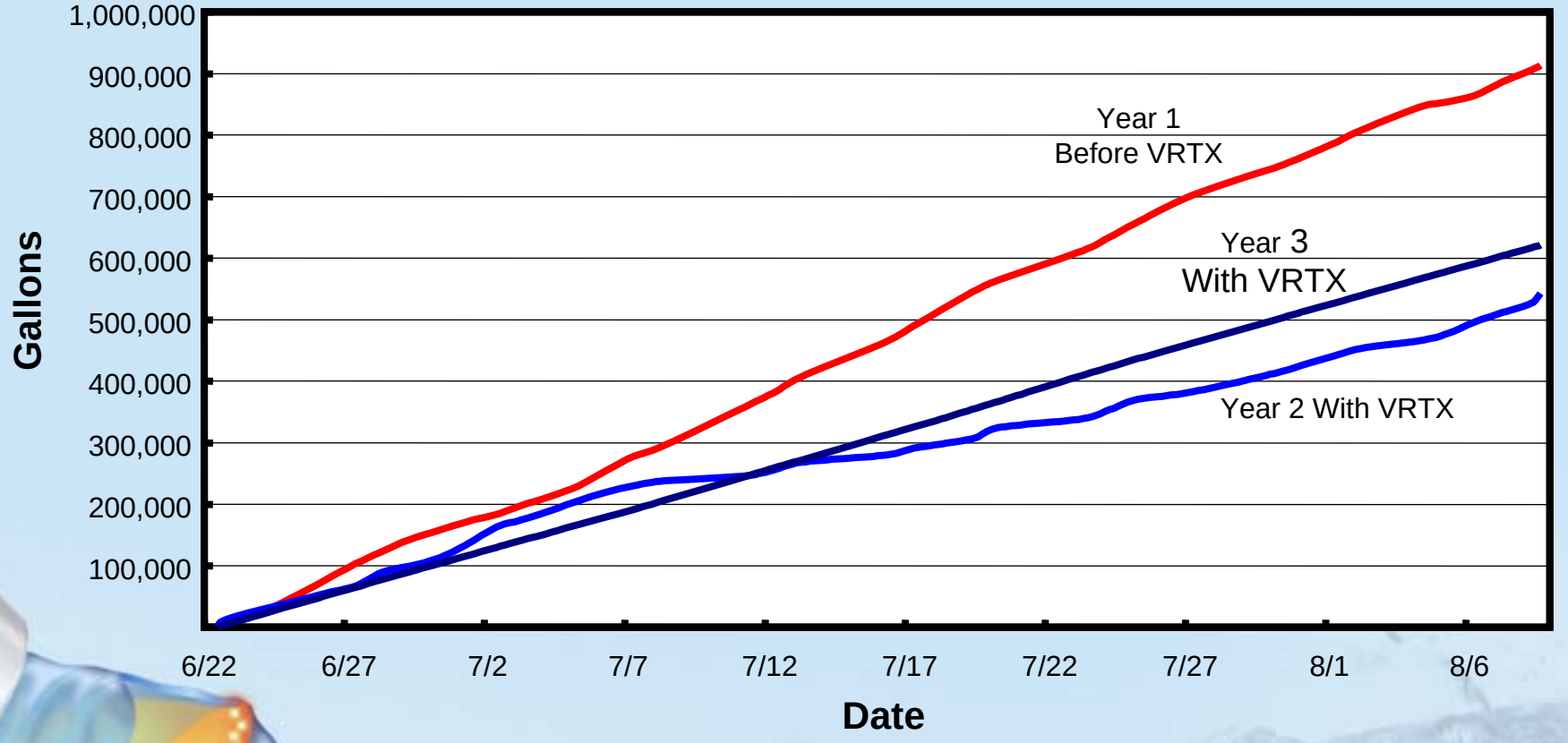
CASE STUDY 2: BREWERY

COMPARISON OF BLOWDOWN



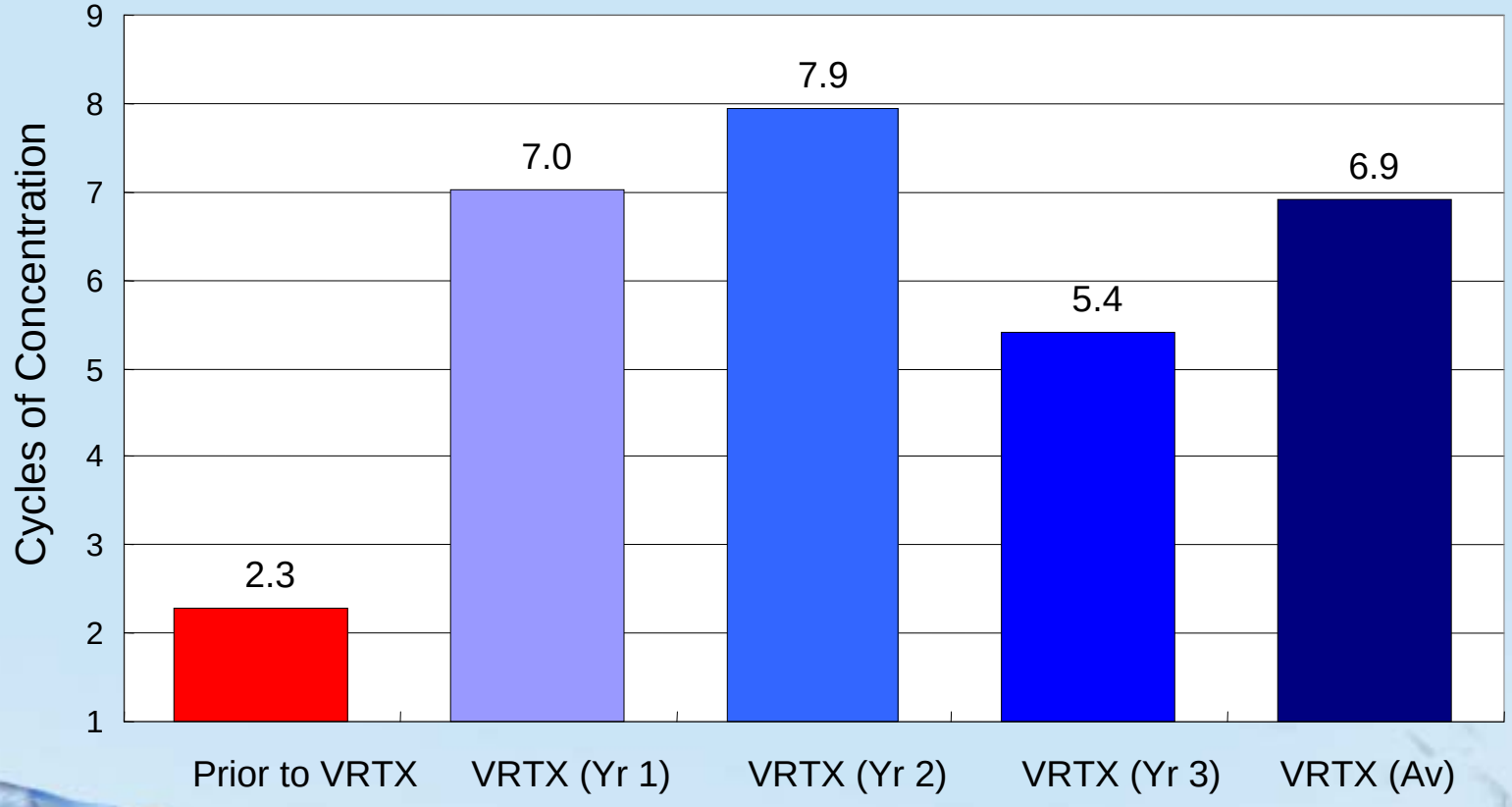
CASE STUDY 2: BREWERY

COMPARISON OF MAKEUP CONSUMPTION



CASE STUDY 2: BREWERY

COMPARISON OF CYCLES OF CONCENTRATION



CASE STUDY 2: BREWERY

RESULTS

Old scale was gradually removed and no new scale has formed. Total bacteria counts normally range from 400 to 2,500 CFU/ml. Coupon tests show corrosion rates < 2.5 mpy for galvanized and carbon steel and < 0.25 mpy for copper alloy.

SAVINGS

Cycles of concentration now average 7.0. Blowdown has been reduced by 80%. Annual water savings are over 1.8 million gallons. Payback period was less than 12 months.

CASE STUDY 3: JUICE PROCESSOR

CUSTOMER ISSUE

Orange Juice Processor (15,000 tons of refrigeration) wanted to reduce water usage while lowering overall operating cost.

SOLUTION

Three VRTX 250-GPM units and automated filtration system were installed in January 2003.

RESULTS

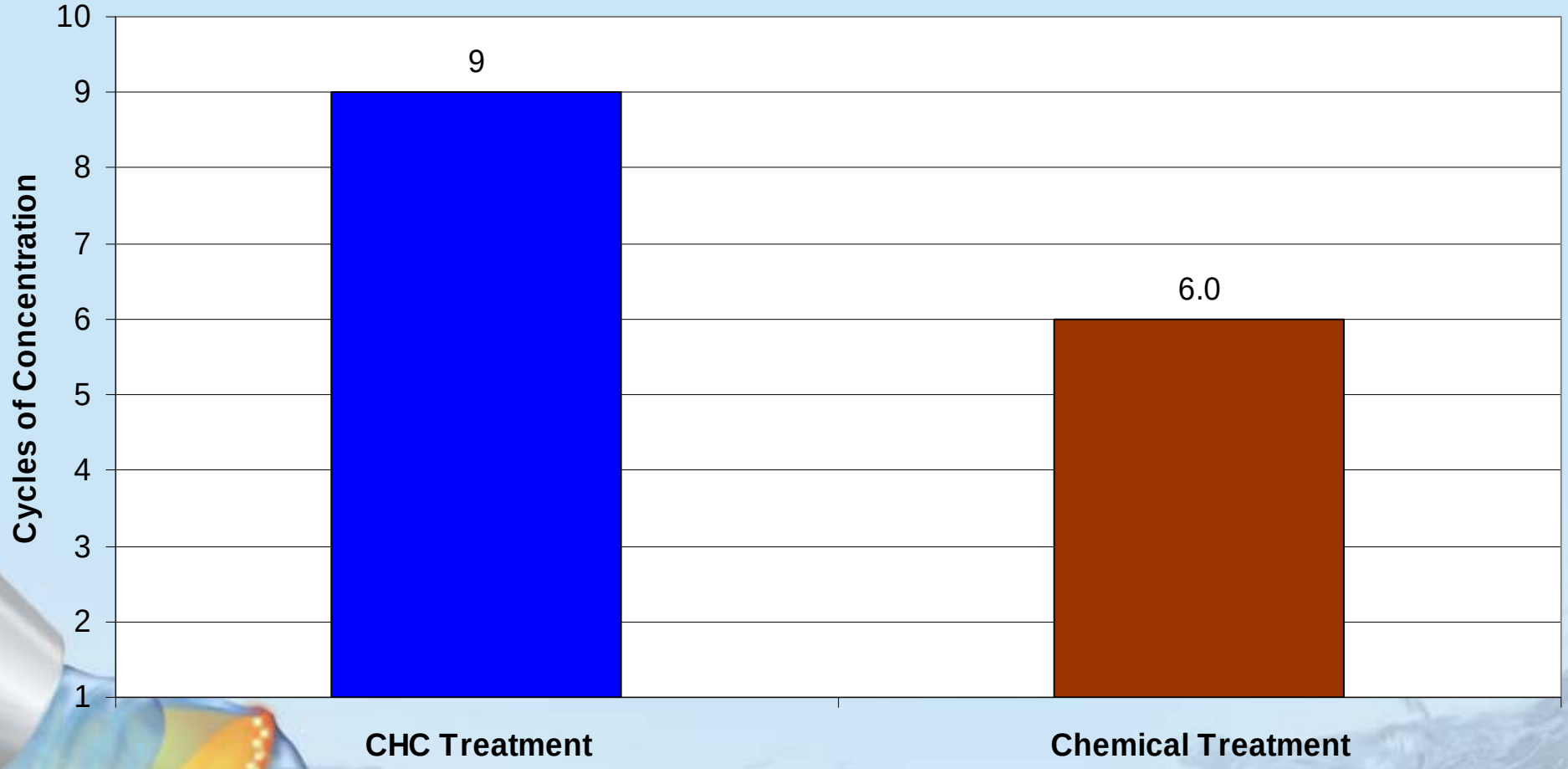
Visual inspections and compressor head pressures showed no scale formation. Corrosion rates < 3.0 mpy for mild & galvanized steel, and < 0.3 mpy for stainless steel. Bacteria counts were 50% less than older systems under chemical treatment.

SAVINGS

Customer is saving over 5 million gallons of water annually. Cost savings exceed $100,000 per year. Project was paid off in less than 22 months. Customer has ability to re-use 2 million gallons of non-potable water per month.

CASE STUDY 3:

Cycles of Concentration: CHC vs. Chemical



CASE STUDY 4: STATE UNIVERSITY

CUSTOMER ISSUE

A public university has a four-celled, 6,000 gallon cooling tower with a recirculation rate of 4,800-GPM. Scale, fouling, and bacteria activity were all issues under chemical treatment.

SOLUTION

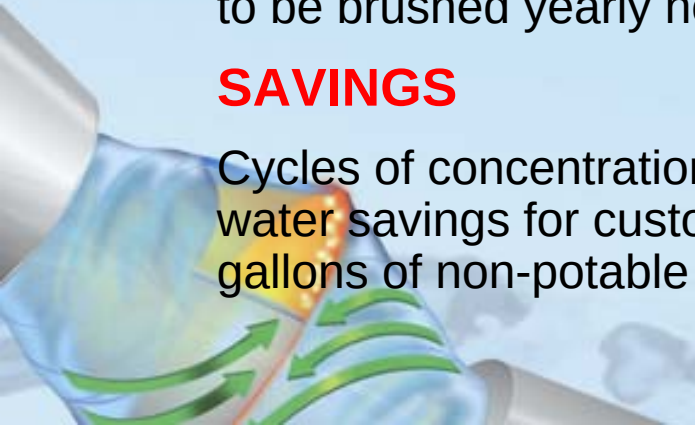
A VRTX 80-GPM unit and filtration system were installed in July of 2001.

RESULTS

Cycles of concentration increased after VRTX installation, with customer blowdown being reduced by 75%. Chiller tubes which used to be brushed yearly no longer require cleaning.

SAVINGS

Cycles of concentration increased with the VRTX system. Annual water savings for customer exceed two million gallons, with one million gallons of non-potable water available for re-use.



Case Study 5:
Distribution Center, UK

2 x 3,400 Kw Evaporative Condensers

1 Chemically Treated

1 CHC Technology Treated

16 Week side by side Comparison

Case Study 5: Distribution Center

Cycles increased from 2.5 to 4

- **Chemical Saving $16,000/yr**
- **Water & Effluent Savings $16,000/yr**
- **Water consumption reduced by 1.05 MM gal**
  - **Greenhouse gases reduced by 7.2 ton**
  - **Energy savings 10.6Mw**
  - **Chemical savings 1 ton**

SUMMARY
CHC TECHNOLOGY

- **Effective at Controlling:**
  - **Scale**
  - **Corrosion**
  - **Bacteria**
- **Saves Water By Running Higher Cycles**
- **Reduces Energy Consumption By Operating a Cleaner System**

OTHER BENEFITS

- **“Green” Technology**
  - **Zero Chemicals in System**

- **CHC Eligible for Utility Water Rebates in Some Areas (California, Nevada, etc.)**

- **CHC Qualifies for USGBC LEED-NC (New Construction) Innovation and Design (ID) Credit 1.1. An additional point may be earned (Water Efficiency 1.2) by utilizing cooling tower blowdown for landscape irrigation purposes.**

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QUESTIONS?

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