How to Reduce Water & Energy Consumption in a Cooling Tower?

Gerry Van den Eynde – Area Sales Manager
• Introduction
• History
• Product Lines
Regional Energy Consumption

77% energy consumption
- Buildings

70% buildings energy
- Cooling
Global facilities & partners

Headquarters (1)
Wholly owned (11)
Joint Ventures (1)
Licensees (1)
15x direct BAC employees

35 x BAC representative employees

*ME Sales* (new projects)

*ME After-Market* (new & installed equipment)
Technology commitment

- +100 patents technology innovation.
- 5000 m² R&D & test facility.
- > 40 engineers
1940: Factory assembled evaporative condensers and cooling towers

1950: Industrial fluid cooler replacing cooling tower with heat exchanger

1960: Corrosion protection more than hot-dip galvanized steel

1970: Axial fan forced draft countercflow coolers or condensers

1980: New coil and water distribution system design
**HISTORY**

- **1980**
  - Baltibond Corrosion Protection System
  - Finned coils
  - Dry operation

- **1990**
  - Ice thermal storage units
  - BACcount fill
  - Combined flow technology – coil on fill
  - HXI hybrid cooler

- **2000**
  - Eurovent certification
TrilliumSeries Adiabatic coolers
Water saving evaporative condensers - HXC

HFL - Water saving evaporative coolers with remote cold water basin
Heat exchanger skid

New generation Baltibond hybrid coating
Eurovent certification
Open cooling towers
CO₂ condenser
2015
OptiCoil PFI
Eurovent certification
Closed circuit cooling towers

2017
TrilliumSeries TVFC
Adiabatic cooler

2018
Polairis™ Evaporative condenser
Nexus™ Modular hybrid cooler
Product Line
BAC extensive product line

- Open cooling towers
- Closed circuit Cooling towers
- Water saving hybrid wet-dry
- Evaporative condensers
- Thermal storage units
Open Cooling towers

Centrifugal fans

VT 0/1

VTL-E

Axial fans

Series 3000E

Series 1500E

PTE
Closed circuit Cooling Towers

Centrifugal fans
- VXI
- VFL

Radial fans
- ! NEXUS !

Axial fans
- PFI
- FXVS
- FXVT
Dry, Adiabatic and hybrid cooling

Axial fans
- DFC
- SpartiumCooler
- TrilliumSeries Cooler
- HXI

Centrifugal fans
- HFL
- VXI + PAC+ 3-way valve
Refrigerant Condensers

Centrifugal fans
- VXC
- VCL

Radial fans
- POLAIRIS

Axial fans
- CXVE
- CXV-D
- PCE
How to Reduce Water & Energy Consumption in a Cooling Tower?

Jai Kawrani - Application Manager
Agenda

Ways to Reduce Energy Consumption

• System Optimization
• Innovative Technologies
• System Efficiency & Reliability

Ways to Reduce Water Consumption

• Water Usage & Chemistry
• Cycle of Concentration & Bleed
• Advanced Materials of Construction

Value Pack
Industry Standards Evaluation
HVAC Industry Evolving

Owners → Reduce Total Cost of Ownership

• More Energy Efficient Products Required
• Lower Operating Expenses
• Global Energy Codes and Regulations

Innovative Building Design and Operating Strategies

New Technologies
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>2010 Performance Required</th>
<th>2013 Performance Required</th>
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<tbody>
<tr>
<td>Open Loop Axial Fan</td>
<td>≥ 38.2 gpm/hp</td>
<td>≥ 40.2 gpm/hp</td>
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<tr>
<td>Cooling Towers</td>
<td></td>
<td></td>
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</tbody>
</table>

5% rating increase from 2010 to 2013 for Axial Fan Units
Ways to Reduce Energy Consumption
System Optimization - Design for Lower Approach

Tower / Chiller Optimization

Reduce Approach

- Optimize Tower and Chiller Sizes with Energy Cost Estimates
- At least 2.5% Reduction in Energy Use per degree below 90°F
Range and Approach

Cooling Tower → Controls the Approach

500 Ton Cooling Tower @ 1,500 gpm, Full Fan

• 95/85/78 (10 degree range) = 7.0°F Approach
• 102.6/87.6/78 (15 degree range) = 9.6°F Approach
• 86.8/81.8/78 (5 degree range) = 3.8°F Approach

› Reduces energy usage by 10%

Closer Approaches

• Colder condenser water increases higher efficiency
Chiller and Cooling Tower System Optimization

<table>
<thead>
<tr>
<th></th>
<th>First Cost</th>
<th>Energy Cost</th>
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<tbody>
<tr>
<td>Cooling Tower</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Chiller</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Pump</td>
<td>✓</td>
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<tr>
<td>Condenser Water Piping</td>
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Innovative Technology
EXTREME EFFICIENCY COOLING TOWERS

2 x the ASHRAE 90.1 energy ratings

HOW TO SELECT

- Increase heat transfer surface area
- Reduce CFM and HP
- Compare ASHRAE 90.1 GPM/HP ratings

EXAMPLE: 500 nom. tons (1,500 gpm 95/85/78)
- Model S3E-1020-07P, 40 HP fan motor
- Model XES3E-1424-07M, 20 HP fan motor
Inputs:
- $0.12 / kW
- 2,500 hours
- 20 years

Series 3000 Cooling Tower

$99,500 Savings

Cost

Series 3000
Series 3000 XE Model

Operating Costs
First Costs

500 TON SELECTION COMPARISON
Extreme Efficiency Cooling Towers

Lowers operating cost

- Typical Payback in less than 2 years
- Energy reduction up to 75%

Reduced sound levels up to 5dB

Increases system reliability

- Less wear and tear on mechanicals

Helps contribute to energy and atmosphere LEED® credits
Drive System Selection Guide

**GOOD**

**GEAR DRIVE**
- Common for larger HP applications
- Highest maintenance costs
- Highest potential for downtime

**BELT DRIVE**
- Proven and most popular for HVAC applications
- Quick service, lower maintenance costs

**BEST**

**DIRECT DRIVE**
- Highest reliability
- Superior energy savings
- Lowest maintenance costs
- Lowest total cost of ownership

Both belt and gear have mechanical losses
Unmatched Reliability

- No misalignment issues
- No transmission components to fail

90% Reduction in Maintenance

- Up to 7 years between maintenance
- No more oil changes

Increased Thermal Performance
Direct Drive Technology

10% ENERGY SAVINGS

• No losses from Gears and Couplings
• No degradation over time

OPERATED BY VFD

• Additional Energy Reduction

Noise Elimination from Conventional Gear Drive Systems
When to Consider Direct Drive

- Loss of Maintenance Staff
- Need More Capacity
- Eliminate Gear Misalignments
- Reduce Vibration Levels
Direct Drive - TCO Analysis

TOTAL COST OF OWNERSHIP
Over 20 Year Life

GEAR Drive Fan System

$118,927 Savings

*100 HP motor, $0.12 per kWh, 2,500 equivalent full-load hours, $10 per kW demand charge
Dubai Airport Free Zone Authority

Before

After
Gloria Hotel, Dubai

Before

After
Innovative Technologies
System Efficiency & Reliability
System Efficiency and Reliability

OPEN SYSTEM CHALLENGES

Fouling reduces efficiency, increases operating costs
**OPEN COOLING TOWER**

Water outlet = Twb + Approach

**OPEN COOLING TOWER + CLOSED HEAT EXCHANGER**

Water outlet = Twb + Approach + ΔT_{HX}

**CLOSED CIRCUIT COOLING TOWER**

Water outlet = Twb + Approach
Closed Circuit Cooling Tower Advantages

Reduced fouling minimizes:
  • Maintenance costs, energy costs, downtime

Can eliminate need for heat exchanger:
  • Simplifies system
  • Reduces installation cost

Greater layout and operation flexibility
Ways to Reduce Water Consumption
Blow down (via Cycles of Concentration) is the only significant variable to control in Cooling Towers for reducing Water Usage.
# Total Water Usage in Cooling Towers

## 3 Cycles

- **Evaporation**: 66%
- **Blowdown**: 33%
- **Drift**: 1%

<table>
<thead>
<tr>
<th>Cycles</th>
<th>Gallons / Ton</th>
<th>Evaporation</th>
<th>Blowdown</th>
<th>Drift</th>
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<tbody>
<tr>
<td>3</td>
<td>2.7</td>
<td>1.8</td>
<td>0.9</td>
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</table>

## 6 Cycles

- **Evaporation**: 83%
- **Blowdown**: 16%
- **Drift**: 1%

<table>
<thead>
<tr>
<th>Cycles</th>
<th>Gallons / Ton</th>
<th>Evaporation</th>
<th>Blowdown</th>
<th>Drift</th>
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<tr>
<td>6</td>
<td>2.2</td>
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Water contains impurities

- MINERALS
  - Calcium
  - Magnesium
  - Sodium
  - Iron

- AIR
  - Oxygen
  - Carbon Monoxide
  - Carbon Dioxide

- EARTH
  - Clay
  - Silt
  - Sand

Dissolved solids
Dissolved gases
Suspended matter
**Critical Water Chemistry data**

**Total Dissolved Solids (TDS)**
- Ca, Mg, Na, iron, 
- Measured by the Conductivity

**Hardness (TH)**
- Ca & Mg ions dissolved in water
- Typical Measure: Total Hardness

**Alkalinity (TAC)**
- Carbonate (CO₃) or Bicarbonate (HCO₃)

**Chlorides and Sulfates**
- Salts can be corrosive to metals at high levels

**pH**
Impact of Bleed on Cycle of Concentration

Constant Evaporation

With Zero Bleed
- Solids build up over time

With Continuous Bleed
- Solids levels stay balanced with proper bleed

Constant Evaporation

Maintaining Set Cycles
Cycles of Concentration vs Blow Down

Blow Down / Evap. Loss

Cycles of Concentration

EXPENSIVE

CRITICAL
Advanced Materials of Construction
Materials of Construction

- **G235 Galvanized Steel**: Low Cost / Higher Water Usage

- **Special Hybrid Polymer Protection**: Value for money / Less Water Usage

- **Water Touched Stainless Steel**: Medium Cost / Less Water Usage + High protection to Chlorides

- **Stainless Steel**: High cost / Less Water Usage + Highest resistance against Chlorides

- **Evertough**: Less Water Usage + Ultra strong & corrosion resistant basin construction
G235 with Special Hybrid Polymer + FRP

Casing: FRP

- Less Water Usage
- Value for money
- Light Weight, Corrosion & UV resistant Casing
- Equivalent to SS304 Water Usage
Baltibond Hybrid Coating

Fuse-bonded to galvanized steel substrate

- Protective coating
- Zinc
- Steel
- Zinc
- Protective coating
Water touched Stainless Steel

Frame: G235 with Special Hybrid Polymer

Casing: FRP

Basin: SST

+ Less Water Usage
+ High protection to Chlorides
- Medium Cost
Full Stainless Steel

+ Less Water Usage
+ High resistance against Chlorides
- High Cost
### Stainless Steels: Differences Matter

<table>
<thead>
<tr>
<th>Type</th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Si</th>
<th>Cr</th>
<th>Ni</th>
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<td>19.00/22.00</td>
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<td>10.00/14.00</td>
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</tr>
</tbody>
</table>
Stainless Steels: Differences Matter

Figure 1
Effect of Chromium Content on Corrosion Rate (2)
Stainless Steels: Differences Matter

Table X: Alloy grades according to molybdenum content

<table>
<thead>
<tr>
<th>Molybdenum Content</th>
<th>Applicable Alloys</th>
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<tbody>
<tr>
<td>0</td>
<td>Types 301, 302, 303, 304, 304L, 304N, 304LN, 305, 308, 309, 310, 321, 347</td>
</tr>
<tr>
<td>2</td>
<td>Types 316, 316L, 329</td>
</tr>
<tr>
<td>3</td>
<td>Types 317, 317L</td>
</tr>
<tr>
<td>3.5</td>
<td>Alloy 825</td>
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<tr>
<td>4</td>
<td>Alloy 904L, Types 317LM, 317LMN</td>
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<tr>
<td>6</td>
<td>AL-6XN, 25-6Mo, 254SMO, Alloy G, Alloy G-3</td>
</tr>
<tr>
<td>9</td>
<td>Alloy 625</td>
</tr>
</tbody>
</table>
304 vs 316 at 30 deg C

Figure 1: Drinking water qualities
EVERTOUGH™ Construction

- FRP Casing Panels
- TriArmor® Cold Water Basin
- Thermosetting Hybrid Polymer Protected Structural Members
- Strainer and other Submersible Components are Constructed of 304 SST
- PFRP Hot Water Basin with Type 304 SST Covers
- FRP Air Intake Louvers

+ Less Water Usage
+ Ultra strong construction
+ Strongest Cold Water Basin
Advanced Materials of Construction

- Thousands of Installations
- Eliminates Basin Leaks
- Protects Basin Surfaces from corrosion and system upsets
- Reduce Water usage

1. G-235 Heavy Galvanized Steel
2. Thermosetting Hybrid Polymer
3. Impermeable Polyurethane Barrier
### The Cold Water Basin

#### The TriArmor® Corrosion Protection System

<table>
<thead>
<tr>
<th>Polyurethane Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermosetting Hybrid Polymer</td>
</tr>
<tr>
<td>2.35 oz of zinc/sq ft</td>
</tr>
<tr>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>2.35 oz of zinc/sq ft</td>
</tr>
<tr>
<td>Thermosetting Hybrid Polymer</td>
</tr>
</tbody>
</table>
Average Cold Water Basin Price

- Galvanized Steel
- Type 304 Stainless Steel
- Type 316 Stainless Steel
- TriArmor® Corrosion Protection System
<table>
<thead>
<tr>
<th>Property of Water</th>
<th>Galvanized Steel</th>
<th>Thermosetting Hybrid Polymer</th>
<th>Type 304 Stainless Steel</th>
<th>TriArmor® Corrosion Protection System or Type 316 Stainless Steel</th>
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</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5 to 9.0&lt;sup&gt;[1]&lt;/sup&gt;</td>
<td>6.5 to 9.2&lt;sup&gt;[1]&lt;/sup&gt;</td>
<td>6.5 to 9.2&lt;sup&gt;[1]&lt;/sup&gt;</td>
<td>6.5 to 9.5&lt;sup&gt;[1]&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>25 ppm</td>
<td>25 ppm</td>
<td>25 ppm</td>
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<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>1,500 ppm</td>
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<td>Conductivity</td>
<td>2,400 (microohms/cm)</td>
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<td>3,300 (microohms/cm)</td>
<td>4,000 (microohms/cm)</td>
</tr>
<tr>
<td>Calcium Hardness as CaCO₃</td>
<td>50 to 600 ppm&lt;sup&gt;[2]&lt;/sup&gt;</td>
<td>50 to 750 ppm&lt;sup&gt;[2]&lt;/sup&gt;</td>
<td>50 to 750 ppm&lt;sup&gt;[2]&lt;/sup&gt;</td>
<td>50 to 750 ppm&lt;sup&gt;[2]&lt;/sup&gt;</td>
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<tr>
<td>Chlorides (CL)</td>
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<td>750 ppm</td>
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<td>Sulfates</td>
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<td>350 ppm</td>
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<td>750 ppm</td>
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<tr>
<td>Silica</td>
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<td>150 ppm</td>
<td>150 ppm</td>
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</table>

Material of construction = Water Quality & Water Consumption!
Value Pack
Cooling Towers are ‘Air Washers’!
Filtration Package & Sump Sweeper Piping

Sump Sweeper Piping + Matching Separator

THE PERFECT COMBINATION
Cyclonic Separator

Removal of Suspended Solids in the Recirculating Water

Typically 25% Biocide and Inhibitors Savings per year
Sump Sweeper Piping

- Increased Water Agitation
- Improved Filtration Performance
- Less Suspended Solids
- Less Biological Growth

25% less Biocide and Inhibitors per year
Automatic Dosage => BCP 3 D

• Minimize Water Usage
• Allow Consistent Water Quality
• Appropriate Dosage of Inhibitor - 1 & Biocides - 2
Product with Innovative Technology

Advanced Material of Construction

Water Treatment Control Package

Filtration Package

Sump Sweeper Piping

Expert Maintenance Services