Eliminating the High Cost of Over Pumping
Eliminating the High Cost of Over Pumping

- Flow Study and Pumping Cost Analysis
- System Design and Sizing (Valve-Coils-Chillers)
- Pressure Independent Valves/Dynamic Balancing
- Delta T Management, Correcting Low Delta T
- Case Studies
- Data Analysis, Optimization and Functionality
- Calculate Savings
- Heating Applications
- Systems Running as Designed
Independent Energy Modeling Study
Chilled Water System, Average Delta T = 6
Peak Load 26,000 Tons

* From 2008 Chilled Water Delta T Study
Independent Study
Savings by Eliminating Low Delta T
Increase DT from 6 to 12 degrees (12 = Design)

Recommend implementing chilled water delta T improvement projects across the campus.

<table>
<thead>
<tr>
<th>Component</th>
<th>Annual Energy Savings</th>
<th>Annual Cost Savings</th>
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<tbody>
<tr>
<td>Chiller Steam</td>
<td>10,887 Mlbs</td>
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<tr>
<td>Chiller Electric</td>
<td>2,576,000 kWh</td>
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<td>CW Pump Electric</td>
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<td>CT Fan Electric</td>
<td>740,000 kWh</td>
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<td><strong>TOTAL SAVINGS</strong></td>
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<td><strong>$1,471,000.00</strong></td>
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25% of Total
Pressure Independent & Delta T Manager
Pump Savings in Large Tech Company in NC

Delta T vs. Tons - B500 AHU3

- Pressure Independent
- Pressure Dependent

Delta T Manager + PI
Pressure Independent (PI)
Pressure Dependent

- 96 GPM
- 144 GPM
- 240 GPM
At 50% load and 6 degrees DT flow = 1000 GPM
Increasing DT to 12 degrees (design) flow reduces to 500 GPM
Control Valve Sizing

Pressure Dependent Flow Coefficient-Valve Sizing (CV)

- $C_v = \frac{GPM}{\sqrt{\Delta P}}$

- 1 Cv = 1 gallon of 60 DegF water passing through a fully open control valve with a pressure drop of 1 psi.
- Sizing is typically done using a PD of 3-5 PSI
- Manual balancing can not maintain a constant PD and causes overflow and low delta T.

when the pressure drop increases the flow increases
Balancing Valve Sizing & Selecting

**Balancing valves are sized based on GPM. Sizing is generally done using the “nominal flow” (not max or min flow)**

**Setting is done by rotating a handle and adjusting the CV to achieve a specific pressure drop.**

**Balancing Valves are set for one pressure drop and are effected by pressure changes.**

when the pressure drop increases the flow increases
Manual Balancing Valves

when the pressure drop increases the flow increases
Why Systems Over Flow?
Valve Authority

Pressure Differential Sensor

10 psi
∆p = 4 psi
gpm = 0 to 100

20 psi
∆p = 4 psi
gpm = 0 to 100

30 psi
∆p = 4 psi
gpm = 0 to 100

40 psi
∆p = 4 psi
gpm = 0 to 100

Overflow
VFD-Pump

Chiller 1
Chiller 2

Accumulative Waste

A = 4/10 = 0.40
A = 4/20 = 0.20
A = 4/30 = 0.13
A = 4/40 = 0.10

Flow/Heat output %
Flow and delta T are inversely proportional; for a given load, when delta T drops flow has to increases.

\[ GPM = \frac{Tons \times 24}{\Delta T} \]

\[ 2000 \text{ GPM} = \frac{Tons \times 24}{12^\circ \Delta T} \]

\[ 2000 \text{ GPM} = \frac{2000}{2} = Tons \]

\[ Tons = 1000 \]
Cost of Overflow at the Plant

Plant Efficiency

- **Chillers**
  - Plant is more efficient at Design ΔT than at low ΔT
  - Low ΔT (high flows) can cause improper staging

\[
GPM = \frac{Tons \times 24}{\Delta T}
\]

\[
GPM = \frac{500 \times 24}{12} = 1,000
\]

\[
GPM = \frac{500 \times 24}{8} = 1,500
\]
Chilled and Hot Water Coil Design

CHW Coil = GPM, EWT=44, LWT=60, DT=16
HW Coil = GPM, EWT=140, LWT=120, DT=20
CHW DT= 8 will increase pumping X 2, Increase cost X 8.
Low Delta T at the Coil
Delta T Decreases, Flow Increases
No Additional Heat Transferee

Power Output: \[ Q(\text{Btu/h}) = 500 \times GPM \times \Delta T \]
Deny or Choke Valve, will not allow a coil to run as designed. This application will negate proper de-humidification and comfort.
Causes of Low Delta T

- Oversized chillers, pumps, coils, control valves and piping
- Controlling the chilled water valve using only the air sensor is insufficient
- Manual balancing only addresses one flow condition
- Systems rarely run at full load causing overflow at part load
- Hydronic systems are changed but not rebalanced
Correcting Low Delta T
Delta T Management
.5” thru 6” – .5 thru 713 GPM
Terminal Unit Pressure Independent Valve

2-Way PIQCV (Pressure Independent)
½” and ¾” NPT, Fail Last or Fail Safe
Up to 9 GPM
100 PSI Close Off

Mechanical operation
Electronic Pressure Independent Valve Flow Meter Balancing
1/2”– 6”, 1.65 thru 713 GPM
Pressure Independent
Delta T Control + Flow/Btu Meter

1. Actuator
2. Flow Sensor (±2% tolerance)
3. CCV Valve
4. Temperature Sensor (remote)
5. Temperature Sensor
Library Case Study

Case Study Issues

- Coil Delta T reported as 6 Degree F
- Over pumping
- Low Delta T Syndrome at Chiller Plant

6 AHU units, 153,000 sq-ft
Case Study

AHU-6, CHW Delta T with Belimo SL System Globe Valve test
Delta T control deactivated.
Case Study

AHU-6, CHW Delta T with Delta T control active Globe Valve test.
Case Study Setup

- 5 Energy Valves
- 1 Tandem PICCV with Delta T Manager
- Chilled Water is designed to run through a coil at a designed temperature drop to supply air conditioned cooling air and to de-humidify. i.e. Water delta T=12 degrees F.
Case Study
Library Whole Building Results

2011 vs. 2010 Flow

- 8/9-10/9 2010 6.15 F DT
- 8/9-10/9 2011 12.14 F DT

- From whole building meters, Metering data PI archive

- Tons x 24/GPM = Weighted Average Delta T

6 AHU units – 153,000 sq-ft
The DeltaT Manager has been set to ON for 1440 minutes out of the 1 Day of captured data.

The DeltaT Manager status is:

<table>
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<th>Control Mode</th>
<th>Standby</th>
<th>Active</th>
<th>Active %</th>
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<td>Flow Control</td>
<td>960</td>
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<td>Power Control</td>
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The Active % by Control Modes indicates the amount of time the DeltaT Manager has taken control over the DDC signal to prevent over flow and low coil DeltaT.

**SAVINGS CALCULATOR**

The projected flow rate thru the valve if the DeltaT Manager was not enabled would be 152.44 GPM which would have produced 73,170.04 GPM of water compared to the Actual amount of 35,248.80 GPM which is a savings of 52% or 37,921.24 GPM.
New Definitions

• **Power Saturation Point**
  • Point beyond which coil cannot yield additional heat transfer regardless of increased flow.

• **Waste Zone**
  • Range beyond the “Power Saturation Point.”
Energy Valve Delta T Manager Operation

Delta-T Manager Activation

Waste Zone

DDC SIGNAL
Chilled & Hot Water Coil design
Energy Valve/Delta T Manager

Coils function per design GPM and Delta T

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<th>LOCATION</th>
<th>SERVES</th>
<th>VENTILATION DEG.</th>
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<th>EXT. SP.</th>
<th>WHEEL TYPE</th>
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Chiller Plant & Pumps Run as Designed
VFD at Min Flow per Demand

Plant Efficiency
• Chillers
  • Plant is more efficient at Design ΔT than at low ΔT
  • Low ΔT (high flows) can cause improper staging

\[
GPM = \frac{Tons \times 24}{\Delta T}
\]

\[
GPM = \frac{500 \times 24}{12} = 1,000
\]

\[
GPM = \frac{500 \times 24}{8} = 1,500
\]
## Energy Valve Overview

<p>| | |</p>
<table>
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</table>
| **1** | **Actuator**  
Webserver, data logger, BACnet, Modbus, MP-Bus, Cloud capability |
| **2** | **Electronic Flow Meter**  
True Flow, Wet calibrated |
| **3** | **Temperature Sensors**  
Platinum based RTD for supply and return, allowing BTU measurement |
| **4** | **Logic**  
Delta T Management and flow meter, pressure independent balancing |

Measure, Observe, Record and Trend Performance Data
Data Acquisition

The Energy Valve will trend and store:

- Flow
- Delta T
- Energy Output
- Power Output
- Totalized Energy
- Calculate Savings
Data Acquisition

Live information

Device location: Slop Sink EV3

Overview
- Data
- Status
- Settings
  - Application
  - Data & time
  - Users
  - IP
  - BACnet/Modbus
  - Cloud
  - Maintenance

- Status: OK
- Control function: Flow control
- Setpoint DDC: 49.3 %, 6.0 V, 0.4 gpm
- Delta temperature: 0.3 F
- Delta T limiting status: dt: Manager standby, dt: Setpoint: 10.0 F

Flow: 0.0 gpm
Temperature: 71.9 F (Temp T2), 71.6 F (Temp T1)
Power: 0.0 kBTU/h
Valve position: 100 %
Energy Valve
- Data Logging and Storage
- Up to 13 Months of Data
- Export to .csv file format
- Charts, Graphs, Trending

Excel Tool
- Import .csv in to Excel Tool
- Power Curves
- Charts, Graphs, Trending
Optimization

Settings
Enhanced Communication
Unlike Any Actuator on the Market

• 2-10 VDC
• 0.5 -10 VDC
Energy Valve 3.0 Cloud Services

Advanced Optimization with Multiple Benefits

- Optimization of Delta T and Flow Settings
- Performance Report
- Online Support
- Software Updates
- Increase Warranty to 7 Years
- Lifetime Data Access
Data Analysis

Analyzing the Power Curve
Parameterization Tools

Hand Held Device (ZTH-US)

- Quick Programming
- Quick Reconfiguration
- Fast Commissioning
- Local Display
Condensing Boiler Applications Delta T Manager
Set Water Delta T per design

Condensing and return temps

Steady state boiler efficiency %

130°F Dew Point of Natural Gas

Condensing mode
Non-Condensing mode

Boiler return water temp °F
Before Adding Pumps, Chillers & Boilers

Correct Water Delta T

- A plant designed at 500 tons of cooling & 12 Degree Delta T can produce 1000 GPM. At 12 degrees, 40% load, Flow=400 GPM. At 6 degree, 40% load, Flow=800 GPM
- Annual cost at 6 degrees=$24,203, at 12 degrees $9,730.00
Consequences of Over Pumping

- Additional chillers and associated equipment are utilized
  - Chillers run at part load and operated at a higher energy rate per ton of cooling
- Diminished equipment life and increased maintenance needs
- Unstable control
- Compromised occupant comfort
Eliminating the High Cost of Over Pumping

Thank You