Energy cannot be created or destroyed, but it can be wasted.

Knowledge is Power.

The Belimo Energy Valve™
Agenda

- Advantages of PI Valves
- Changes in Coil Performance
- Continuous Commissioning
- The Belimo Energy Valve
Agenda

Advantages of PI Valves
Changes in Coil Performance
Continuous Commissioning
The Belimo Energy Valve
PI Valves

2-way valve that supplies a specific flow for each value of the control signal – 

– Regardless of pressure variations in the system
Effects of Valve Overflow

Issues with Pressure Dependent Valves

• Contributes to low $\Delta T$ at coil

• Over pumping:
  more water $\neq$ more heat transfer

• Instability/Controllability of Flow
Coil Output

Flow Coefficient: \[ Cv = \frac{GPM}{\sqrt{\Delta P}} \]

Changes in \( \Delta P \) resulting in changes to flow

Power Output: \[ Q(\text{Btu/h}) = 500 \times GPM \times \Delta T \]

For a given load, Flow and \( \Delta T \) are inversely proportional. As GPM increases, \( \Delta T \) drops.
Over Pumping

Power Saturation Point

Cooling Output %

Water Flow (%)

Flow

Water DT

Waste Zone
Power Saturation

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

**Waste Zone**
Range beyond the “Power Saturation Point”.
Control Stability

Iowa Energy Center Pressure Independent Valves Study
Chilled Water Close Loop Test

The Pressure Dependent Valve loses authority at part load, it becomes “Oversized”
Control Stability

Iowa Energy Center Pressure Independent Valves Study
Chilled Water Close Loop Test

The Pressure Dependent Valve loses authority at part load, it becomes “Oversized”
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Net Overflow at Part Loads
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Changing Conditions

Coil Performance
Coils

Design and Function

• Heat Exchange Device
• Tubes and Fins
• Designed for Specific GPM @ $DT$
Coils

*Design and Function*

- Heat Exchange Device
- Tubes and Fins
- Designed for Specific GPM @ $D_T$
- Flow determined by control valve
Coils

Heat Transfer Coefficient

- **Air film coefficient** of sensible heat transfer between air and the external surface of the coil
- **Water film coefficient** of heat transfer between the internal coil surface and the coolant fluid within the coil
- **Unit conductance** of the coil material

Based on a coil design with a **clean, non-fouled surface**
Coil Degradation

Heat Transfer of Coil Degrades Over Time

• Damage to Coil or Fins
• Air-side Fouling
• Water-side Fouling
Coil Degradation

Coil Performance

Flow / Coil Power

Control Signal

$\Delta T$
Coil Degradation

Coil Performance

Flow / Coil Power

Control Signal

Power Saturation Point
Coil Degradation

The Coil reaches the Power Saturation Point long before the maximum flow is reached.

Coil Performance

Flow / Coil Power

Control Signal

Power Saturation Point
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Continuous Commissioning

For Hydronic Equipment Coils

Coils degrade over time

Continuous Commissioning allows you to maximize the performance based on the current condition of the equipment.
Analyzing Power Curves

Finding the Power Saturation Point
Analyzing Power Curves

Finding the Power Saturation Point
Analyzing Power Curves

Effects of \(dT\) too Low

If \(dT\) is too low,

Coil is past the Power Saturation Point (overflow)
Coil Degradation

Coil Performance Over Time

Power (BTUH) vs. Flow (%)

Flow (%) vs. Power (BTUH)
Agenda

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Evolution of Control Valves

Characterized Control (position)
Pressure Independent (control of flow)
Flow Measurement (actual flow feedback – live)
Packaged Flow & ΔT Measurement and Control (enables Data Collection & Coil ΔT Management)
Energy Valve

Functionality / Customer Benefit

CCV
PICCV
ePIV

Time
Belimo Energy Valve™

The energy valve is a pressure independent control valve that optimizes, documents and proves water coil performance.
Belimo Energy Valve™

- Actuator
- BACnet
- Flow Sensor
- Valve
- Temperature Sensors (for supply & return water)
Belimo Energy Valve™

Advanced Functions of the Energy Valve

- Data Acquisition for Continuous Commissioning
- Delta T Manager™
1. Benchmarking

Building Design

The first iteration of Benchmarking is the Engineer’s design
2. Data Acquisition

The Energy Valve will trend and store:

- Flow
- ΔT
- Energy Output
- Power Output
- Totalized Energy
2. Data Acquisition

Web View – Live Trending View

Live Trending
- Temperature
- Flow (GPM)
- Power (kW)
- Up to 1hr of Data

Features
- Real Time Data
- Export to .csv
2. Data Acquisition

Data Export and the Excel Tool

Energy Valve
- Data Logging and Storage
- Up to 13 Months of Data
- Export to .csv file format

Excel Tool
- Import .csv in to Excel Tool
- Power Curves
- Charts, Graphs, Trending
2. Data Acquisition

Network Communications

- BACnet MS/TP
- BACnet IP
- TCP/IP
- MP-bus
3. Data Analysis

Analyzing the Power Curve
4. Optimization

Web View - Parameterization Settings View

- Networked, Communicate via Web
- Real Time Configuration
- Real Time Data
Delta T Manager™

Delta T Manager adjusts valve if $\Delta T$ drops below the set point in order to maintain peak coil efficiency.
Flow Control Only

Actual Delta T (°F)

DDC Flow SP

Flow Setpoint (%)

Time

Delta T (°F)

SP (min)
Flow Control Only

Flow Setpoint (%)

Actual Delta T (°F)

DDC Flow SP

Delta T (°F)

SP (min)

Time
Flow Control Only

Actual Delta T (°F)

DDC Flow SP

SP (min)

Delta T (°F)
Delta T Manager™

- Flow Setpoint (%)
- SP (min)
- Delta T (°F)

- Actual Delta T (°F)
- DDC Flow SP
- Delta T Manager Active

Time
Delta T Manager™

- Actual Delta T (°F)
- DDC Flow SP
- Delta T Manager Active
- Delta T Flow SP
Delta T Manager™ – Live Data

The graph shows the relationship between GPM and $\Delta T$ over time. The x-axis represents time, while the y-axis shows GPM on the left and $\Delta T$ on the right. Different lines represent various conditions:

- **$\Delta T$**
- **Delta T Manager On/Off**
- **Valve Set Point (DTM off)**
- **Valve Set Point (DTM on)**

The graph illustrates how the temperature difference ($\Delta T$) changes with time, along with the on/off status of the Delta T Manager and the set points for the valve.
Belimo Energy Valve™

Operational Modes

• Flow Control + Delta T Manager™
• Flow Control

• Position Control + Delta T Manager™
• Position Control

Note: All Operational Modes support full Data Collection (including ΔT)
Belimo Energy Valve™

Benefits

• Commissioning and Diagnostics
  – Monitoring and data collection
  – Continuous Commissioning / Benchmarking

• Coil
  – ΔT Managing for peak coil efficiency
  – Optimization in retro-fit applications
  – More effective control
  – Allows for predictive maintenance

• Pump
  – Reduced pump energy

• Chiller Plant
  – Improved chilled water plant efficiency
  – Released chiller capacity
Questions?

The Belimo Energy Valve™