The Pettinaroli Group

Corporate Profile

Doha
25° April 2015

Prepared by Luca Baroli
An Italian company founded in 1938
HQ – Manufacturing facilities
Group Organization

300 employees – 50 M€ turnover
List of Brands

• The main brand and well known is the logo but recently in 2008 the company mission has been transformed from leading producer of valves and fittings for water gas and heating into

Fratelli Pettinaroli Spa - Climate System Technology
• Key figures: by sales (export to 50 markets worldwide)

- Europe 55%
- Americas 35%
- Middle East 5%
- Far East – Australia 5%
• **Key figures: by product categories**

- Ball valves 52%
- HVAC 32% (PICV-DRV-PCS-Manifolds)
- Radiator valves 11%
- RES & Others 5%
More than 30 approvals worldwide with 20 international bodies
Machining Department
Machining Department
Assembling Department
ISO 14001
Environmental care
Galvanic Department
Product Portfolio

• Ballvalve for water and gas, ecological valves, gate valves and fittings

• Complete mixing unit for underfloor heating and radiators, manifolds and box.

• Complete mixing kit with circulating pump, thermostatics valve with remote sensor, thermometer, integrated non return valve.
Product Portfolio
Manifold pre-assembled config for chilled water distribution

- DRV:s
- DPCV
- By-Pass
- IV:s

CWF

CWR
Product Portfolio
Product Portfolio
Product Portfolio
Product Portfolio

<table>
<thead>
<tr>
<th>COSTI</th>
<th>COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>N° 2 valvole NDA</td>
<td>55 +</td>
</tr>
<tr>
<td>N° 1 filtro NDA</td>
<td>15 +</td>
</tr>
<tr>
<td>installazione</td>
<td>30 =</td>
</tr>
<tr>
<td>TOTALE</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COSTI</th>
<th>COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>N° 1 FILTERBALL</td>
<td>50 +</td>
</tr>
<tr>
<td>installazione</td>
<td>15 =</td>
</tr>
<tr>
<td>TOTALE</td>
<td>65</td>
</tr>
</tbody>
</table>
Balancing of CHILLED water distribution systems: PICV
Pressure Independent and Control Valve

Prepared by Luca Baroli
Agenda

- Introduction of technology
- Fundamentals of technology
- Feasibility, payback and lifecycle cost analysis
Agenda

• **Introduction of technology**
• **Fundamentals of technology**
• **Feasibility, payback and lifecycle cost analysis**
PICV
Pressure Independent and Control Valve

PIBCV
Pressure Independent Balancing Control Valve
Application fields:

Heating and cooling of buildings and other facilities, by means of water-based heat exchanger, where flow and temperature control of air and water is required.

Examples:

• Fan Coil Units – FCU
• Air Handling Units – AHU
• Chilled beams – CB
• Air curtains
• Heating/cooling interface units
• Heat exchangers
What is a PICV?
What is a PICV?
(Pressure Independent Control Valve)

- A combined pre-settable flow limiter and control valve for heat emitters (FCU, AHU, CB …)
- Automatic flow limiter
- Pre-settable maximum flow rate
- Two ports control valve

Because of integrated DPCV, control valve has best authority: at partial load, the system has no influence on temperature regulation as it will have with normal control valves.

\[ Q = K_v \sqrt{\Delta P} \]
Typical Pressure Independent and Control Valve
How a PICV works

The Pressure Independent Control Valve (PICV) has three internal functional groups:

• Temperature control
• Flow rate limitation
• Pressure regulator

Flow rate limitation and temperature control can be combined in some valves

Prepared by Luca Baroli
Differential Pressure (ΔP) Regulator

• The ΔP regulator is the heart of the pressure independent control valve
• Its primary function is to keep a constant differential pressure between P2 and P3, regardless of the instantaneous pressure difference between P1 and P3
Differential Pressure Regulator

- P1 and P3 are transmitted to opposing sides of the diaphragm
- Pressure P2-P3 is the equilibrium point of the regulator
- If P1 > P2-P3 shutter A closes on seat B
- If P1 < P2-P3 shutter A opens away from seat B
Flow Rate Limitation

- Flow rate is determined by formula
  \[ Q = \sqrt{\Delta P} \times K_v \]

- If \( \Delta P \) (P2-P3) is constant \( \rightarrow \) flow rate is only dependent on area of passage (Kv)

- Area of passage is changed linearly in relation to the hand wheel setting
Temperature Control

• Globe valve acts against seat

• Authority ($n$) is defined as the pressure drop across the valve divided by pressure drop across system, in this special case we know that the pressure drop across the valve is held constant ($P_2$-$P_3$) and is almost the same as the total pressure drop across the system

$$n = \frac{P_{\text{valve}}}{P_{\text{system}}}$$

• Flow rate is dependent on stem position (controlled by actuator)
3 way control valves

- Authority calculation
- Complex pipeline
- Need for commissioning
- High capital cost
- High running cost

Prepared by Luca Baroli
2 way control valves

- Authority calculation
- Need for commissioning
- High capital cost (DPCV)
Pressure Differential Sensor

Pressure Independent Control Valve

ΔP

- Authority calculation
- Complex pipeline
- Need for commissioning
- High running cost

Prepared by Luca Baroli
Agenda

• Introduction of technology
• Fundamentals of technology
• Feasibility, payback and lifecycle cost analysis
What is a PICV?

2 Main key features

- Dynamic curve
- Control curve

Prepared by Luca Baroli
Pressure Differential Sensor

Pressure Independent Control Valve

ΔP

- Authority calculation
- Complex pipeline
- Need for commissioning
- High running cost

Prepared by Luca Baroli
**Fluid dynamic curve**

Axial PICV

½” L

Flow rate

\[ \Delta P \]

Portata l/h

590 l/h

560 l/h

590 l/h

520 l/h

Prepared by Luca Baroli
Valve PICV Model VP100AAG serial: 132400003 date 02/09/13

Note: tolerance band of ±5% is referred to whole ΔP range (0.3 – 2.5 bar).
However, if the valve work within a limited ΔP (e.g. 0.5 – 1.5 bar), tolerance is lower.
In the tested example, tolerance is ±2.5%
91H - 1/2" - 780 l/h n° 132050062 test made on 18/09/13

Flow l/h

Start up 35 kPa
Start up 30 kPa
Start up 25 kPa
Start up 20 kPa

Δp mm of water

Prepared by Luca Baroli
What Control Characteristic is Preferred?

![Graph showing relationship between Control Signal (%) and Thermal Output (%)]

- Power Output
Coil Characteristics

<table>
<thead>
<tr>
<th>Application</th>
<th>a-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Heating Coil</td>
<td>0.25 to 0.4</td>
</tr>
<tr>
<td>Heating Coil</td>
<td>0.15 to 0.4</td>
</tr>
<tr>
<td>Cooling Coil</td>
<td>0.25 to 0.5</td>
</tr>
<tr>
<td>Radiators</td>
<td>0.5 to 0.65</td>
</tr>
<tr>
<td>Converters</td>
<td>0.5 – 3.0</td>
</tr>
</tbody>
</table>
Combined control Characteristics

Flow, Signal (%)

Flow, Thermal Output (%)

Characteristic of Coil

Power Output

Characteristic of Control Valve
Valve Characteristic

IEC 60534 – 1 – 2 – 3 – 4
ANSI/ISA-75.01.01-2007
## Valve Characteristic

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
</table>

### Source

**Indian Standard**

**INDUSTRIAL-PROCESS CONTROL VALVES**

PART 2  FLOW CAPACITY

Section 1  Sizing Equations for Fluid Flow Under Installed Conditions
COIL POWER OUTPUT CHARACTERISTIC

Exact curve depends on device

VALVE CHARACTERISTIC

QUICK-ACTING
LINEAR
EQUAL PERCENTAGE

Prepared by Luca Baroli
Control curve
Using a differential pressure gauge to measure the pressure drop the valve absorbs, allows to check whether the valve is in the operating range (and, therefore, whether the flow is constant) by simply verifying that the measured value P1 - P2 is higher than the start-up value.
If the ΔP measured value is lower than the start-up value, then the valve works as a fixed orifice valve.
Start-up value varies with flow setting of the valve, as shown by the example below:
Flow rate verification

FO-PICV vs VO-PICV
FO-DRV vs VO-DRV

VO-DRV
Variable Orifice Double Regulating Valve

FO-DRV
Fixed Orifice Double Regulating Valve

Prepared by Luca Baroli
VO-DRV

ΔP

Kv ≠ constant

Expected measuring Accuracy: ±10 -- 20

Accuracy NOT constant

Prepared by Luca Baroli
FO-DRV

\[ \Delta P_{Kv_s} = \text{constant} \]

Expected measuring Accuracy: ±3 -- 5

Constant accuracy
Fixed Orifice
Pressure Independent and Control Valve

**FO-PICV** → use of fixed restriction to determine actual flow

Variable Orifice
Pressure Independent and Control Valve

**VO-PICV** → use of control valve drop to determine actual flow
ΔP reading across control valve

- Full stroke PICV → better readings
MEASURING ACCURACY

Maximum flow deviation at different settings

*) Position
FO-PICV Example

$\Delta P$ reading across fixed orifice
$\text{FLOW} = \sqrt{P_3 - P_4} \times K_{vs}$

$K_{vs} = \text{constant}$
Comparison:

$\Delta P$ reading:
- Across variable orifice
- Across fixed orifice
- Venturi

![Graph showing comparison of $\Delta P$ reading across different orifices.](image-url)
Definitive guide to pressure Independent and control valves

By Pettinaroli
<table>
<thead>
<tr>
<th>System Commissioning</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre commissioning checks</td>
<td>29</td>
</tr>
<tr>
<td>System with pre-settable valves</td>
<td>29</td>
</tr>
<tr>
<td>Method 1 – Setting against flow measurements</td>
<td>29</td>
</tr>
<tr>
<td>Method 2 – Pre-set, measure and trim</td>
<td>30</td>
</tr>
<tr>
<td>Remote setting of valves by BMS controller</td>
<td>30</td>
</tr>
<tr>
<td>Method 3 – Setting under falling pressure condition</td>
<td>30</td>
</tr>
<tr>
<td>Method 4 – Setting under rising pressure condition</td>
<td>31</td>
</tr>
<tr>
<td>Commissioning incomplete systems</td>
<td>31</td>
</tr>
<tr>
<td>Commissioning by reference points</td>
<td>32</td>
</tr>
</tbody>
</table>
PICV Video
Portfolio
\(\frac{1}{2}'' - \frac{3}{4}''\) - DN 15 – DN20 EvoPICV
1” - DN 25 EvoPICV
PICV 1 ½" - 2"
Large size PICV

2" up to 6"

Ductile iron body

Special multi/function actuator
Smart Actuator
Control valve
Balancing valve
$\Delta P$ reducer
DPCV
Actuators:

Up to DN32

Thermal electric
- 3 mm stroke
- 6 mm stroke
- ON/OFF
- 0-10 V signal

Electromotive
- 3 mm stroke
- 6 mm stroke
- ON/OFF
- 0-10 V signal
Actuators:

DN40-DN50-DN65

Electromotive

- 90° stroke
- ON/OFF
- 0-10 V signal
Actuators:

DN50 - - DN150

Electromotive

- Variable stroke (multi turn)
- ON/OFF
- 0-10 V signal
Unique valve code

131610010

10th valve of the day
Day of test: 161th of the year
Year of test: 2013

Prepared by Luca Baroli
PICV Production Video
Coffee Break
Pre-Fabricated Solutions
Extended range of solutions

**XT600 60/40 mm - 1/2"**
- Rushing bypass with pressure independent control valve and Filterball shut off valve with integrated strainer.
- 60/40 mm pipe centres
- Flow rate from 15 l/h up to 780 l/h
- 1/2" F x 1/2" F
- Filtering capacity 700 μm

**XT601 60/40 mm - 1/2"**
- Rushing bypass with pressure independent control valve and Filterball shut off valve.
- Coil connection set with blow down valve and option port.
- 60/40 mm pipe centres
- Flow rate from 15 l/h up to 780 l/h
- 1/2" union end connections x 1/2" F
- Filtering capacity 700 μm
Extended range of solutions

**XT800** 80 mm - 3/4"
- Flushing bypass with pressure
- Independent control valve and Filterball shut-off valve with integrated strainer.
- 80 mm pipe control
- Flow rate from 100 l/h up to 1500 l/h
- 3/4" F x 3/4" union end connections
- Filtering capacity 700 µm

**XT800** 80 mm - 1"
- Flushing bypass with pressure
- Independent control valve and Filterball shut-off valve with integrated strainer.
- 80 mm pipe control
- Flow rate from 100 l/h up to 1500 l/h
- 1" double union end connections
- Filtering capacity 700 µm

Prepared by Luca Baroli
Extended range of solutions – compact versions
Extended range of solutions – compact versions
Extended range of solutions – 4 pipe system config
Retrofit jobs – PICV as flow limiting device
Agenda

- Introduction of technology
- Fundamentals of technology
- Proprietary specifics of the product line
- Case Studies
- Feasibility, payback and lifecycle cost analysis
- Way forward
Case Study

By-pass arrangement UK
123 Victoria
<table>
<thead>
<tr>
<th>Project</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>123 Victoria Street</td>
<td>Commercial/Offices</td>
</tr>
</tbody>
</table>

**Site Details**

<table>
<thead>
<tr>
<th>123 Victoria Street</th>
<th>M &amp; E Contractor</th>
<th>Consultant</th>
<th>PICV Type</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>Micheal J Lonsdale</td>
<td>Long &amp; Partners</td>
<td>Rotary</td>
<td>1,907</td>
</tr>
<tr>
<td>GB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Near Victoria underground station
City of Westminster - London
Testing at BSRIA Ltd.
Project References
Project Name: LANDMARK TOWER
Client: LANDMARK GROUP
Consultant: ARCH GROUP
MEP Contractor: TRANSGULF ELECTROMECHANICAL
No of PICV’S: 676
Dubai

Project Name: **AL HABTOOR CITY (3 HOTELS)**
Client: **AL HABTOOR GROUP**
Consultant: **KHATIB & ALAMI**
MEP CONTRACTOR: **HABTOOR LEIGHTON SPECON – DRAKE & SCULL JV**
No of Filter Balls: **2008**
Dubai

Project Name: WINDSOR TOWER @ DUBAI LAND
Client: AL SHAFAR PROPERTIES
Consultant: ARENCO
MEP CONTRACTOR: AL SHAFAR UNITED
No of PICV'S: 1400
Dubai

- Dubai Festival City (Qty 500)
- Al Badia Residential complex (Qty 200)
- First Gulf Bank (Qty +150) --- Supplied but not installed yet.
- Al Badrah Water Front Development (Qty 1200)
Qatar

Viva Bahriya Pearl

1750 EvoPICV
Qatar

P103 Building - Ramaco

471 EvoPICV installed
United Kingdom

Projects managed by Marflow Hydronics Ltd

Shell House London - The tower next to the London eye
636 EVOPICV on manifolds
Chilled beam project, two port control to beams
Consultant: Hurley Palmer Flatt
Contractor: Michael J Lonsdale
Commissioning company: Ashfords
Turkey

Ramada Asia Hotel / İstanbül  722 EvoPICV installed
Turkey

Grand Azur Hotel / Marmaris  610 EvoPICV installed

Prepared by Luca Baroli
Holland

Rabo Bank Amsterdam

600 EVOPICV
Italy

Milan – Sky television new HQ

1500 PICV
Contractor: Cesare Fumagalli S.p.A.
Consultant: Ariatta - Milano
India

Delhi Metro Phase-III

(2 stations commissioned – Janpath & Mandi House)
Consultant Approvals in the GCC area

Arch Group
Arif & Bintoak
Arenco
Wsp
Atkins
Khatib Alami
Ae7
Dimensions Engineering
Consultant Approvals in Qatar

MZ & Partners (MZ&P)

Arab Engineering Bureau (AEB)

Engineering Consultant Group (ECG)

KEO International Consultant (KEO)

Consultant Engineering Group (CEG)

Khatib & Alami (K&A)

Dar Al-Handasa Consultant

Atkins

Prepared by Luca Baroli
Agenda

- Introduction of technology
- Fundamentals of technology
- Feasibility, payback and lifecycle cost analysis
Agenda

ASSESSMENT OF ALTERNATIVE VALVE SOLUTIONS
FOR HEATING AND CHILLED WATER SYSTEMS

Prepared by Luca Baroli
The Author

Chris Parsloe
BSc (Hons) CEng MCIBSE

on behalf of

Pettinaroli S.p.A.
This report was compiled by Chris Parsloe of Parsloe Consulting Ltd. Chris is an independent consultant with 30 years of experience in building services. He is author of the following industry design guides which are relevant to the issues discussed in this report:

CIBSE KS 7: Variable Flow Pipework Systems
CIBSE KS 9: Commissioning of Variable Flow Pipework Systems
CIBSE Commissioning Code W 2010: Water distribution Systems
BSRIA BG 2/2010: Commissioning Water Systems
Report provides an assessment of three pipework systems with different valve solutions for the control of heating or cooling outputs from terminal devices. The aim of the comparison is to establish which valve solution provides the best performance in terms of pump energy consumption, and controllability.
• The 4PV system
  (4 port valve system)

• The DPCV system
  (differential pressure control valve system)

• The PICV system
  (pressure independent control valve system)
SECONDARY PUMPS
4PV system
- Constant volume
- Manual balancing
DPCV system
- Variable volume
- Manual balancing
- DPCV on risers
PICV system
- Variable volume
- Automatic balancing
<table>
<thead>
<tr>
<th>System parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels</td>
<td>5</td>
</tr>
<tr>
<td>Terminal devices units per level</td>
<td>40</td>
</tr>
<tr>
<td>Total number of terminal devices</td>
<td>200</td>
</tr>
<tr>
<td>Spacing between branches and sub-branches</td>
<td>3m</td>
</tr>
<tr>
<td>Height between floor slabs</td>
<td>3m</td>
</tr>
<tr>
<td>Heating/cooling output per terminal device</td>
<td>2kW</td>
</tr>
<tr>
<td>Design delta T for terminal devices</td>
<td>6°C</td>
</tr>
<tr>
<td>Pressure loss across terminal devices</td>
<td>5000Pa</td>
</tr>
<tr>
<td>Distance between pump and most remote terminal device</td>
<td>140m</td>
</tr>
<tr>
<td>Flow rate per terminal device</td>
<td>0.08kg/s</td>
</tr>
<tr>
<td>Total design flow rate through system</td>
<td>15.9kg/s</td>
</tr>
<tr>
<td>Limiting pressure loss per metre used for pipe sizing</td>
<td>250Pa/m</td>
</tr>
</tbody>
</table>
Pump speed control:

For the 4PV system, it is assumed that there is no variation in pump speed – pump flow and pressure remain approximately constant at all times.

For the DPCV system it is assumed that pump speed will be varied so as to maintain a constant differential pressure across the pipework adjacent to the most remote DPCV.

For the PICV system, it is assumed that pump speed will be varied to maintain a constant differential pressure across the pipework at a point two thirds of the way (in terms of pressure loss) along the index circuit (this being the circuit feeding to the most remote terminal unit).
4PV system

<table>
<thead>
<tr>
<th>Component/feature</th>
<th>Pressure loss (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index terminal device</td>
<td>5.0</td>
</tr>
<tr>
<td>Index terminal 4PV</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>Note: 4 port valve sized to achieve authority relative to terminal loss of 5kPa</td>
</tr>
<tr>
<td>Index terminal DRV/OP</td>
<td>2.4</td>
</tr>
<tr>
<td>Pipeline DRV/OPs</td>
<td>2.7</td>
</tr>
<tr>
<td>Strainers</td>
<td>2.8</td>
</tr>
<tr>
<td>NRV</td>
<td>5.2</td>
</tr>
<tr>
<td>Pipework and fittings</td>
<td>76.6 (≈271Pa/m)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>103.3</strong></td>
</tr>
</tbody>
</table>

**Authority of 4PV = 0.62**

**Kv of 4PV = 1**

Prepared by Luca Baroli
DPCV system

<table>
<thead>
<tr>
<th>Component/feature</th>
<th>Pressure loss (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index terminal device</td>
<td>5.0</td>
</tr>
<tr>
<td>Index terminal 2PV</td>
<td>20.7</td>
</tr>
<tr>
<td>Index terminal DRV/OP</td>
<td>2.4</td>
</tr>
<tr>
<td>DPCV</td>
<td>30.0</td>
</tr>
<tr>
<td>Pipeline OPs</td>
<td>6.3</td>
</tr>
<tr>
<td>Strainers</td>
<td>2.8</td>
</tr>
<tr>
<td>NRV</td>
<td>5.2</td>
</tr>
<tr>
<td>Pipework and fittings</td>
<td>77.4 (=274 Pa/m)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>141.8</strong></td>
</tr>
</tbody>
</table>

Authority of 2PV = 0.56
Kv of 2PV = 0.64
## PICV system

<table>
<thead>
<tr>
<th>Component/feature</th>
<th>Pressure loss (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index terminal device</td>
<td>5.0</td>
</tr>
<tr>
<td>Index terminal PICV</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Note: PICV loss necessary to enable PICV to operate within its range.</td>
</tr>
<tr>
<td>Index terminal OP</td>
<td>2.4</td>
</tr>
<tr>
<td>Pipeline OPs</td>
<td>2.7</td>
</tr>
<tr>
<td>Strainers</td>
<td>2.8</td>
</tr>
<tr>
<td>NRV</td>
<td>5.2</td>
</tr>
<tr>
<td>Pipework and fittings</td>
<td>80.5 (=285Pa/m)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>123.6</strong></td>
</tr>
</tbody>
</table>
# Maximum, minimum and 50% load operating points for example systems

<table>
<thead>
<tr>
<th>System</th>
<th><strong>Max load</strong> (see Note 1)</th>
<th><strong>Min load</strong> (see Note 2)</th>
<th><strong>50% load</strong> (see Note 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4PV system</td>
<td>103.3kPa @ 15.9l/s</td>
<td>103.3kPa @ 15.9l/s</td>
<td>103.3kPa @ 15.9l/s</td>
</tr>
<tr>
<td>DPCV system</td>
<td>141.8kPa @ 16.6l/s</td>
<td>63.8kPa @ 0.7l/s</td>
<td>83.3kPa @ 8.3l/s</td>
</tr>
<tr>
<td>PICV system</td>
<td>123.6kPa @ 16.6l/s</td>
<td>42.3kPa @ 0.7l/s</td>
<td>63.2kPa @ 8.3l/s</td>
</tr>
</tbody>
</table>

Notes:

**Note 1:** Maximum load pressure losses are as summated in Tables 2, 3 and 4. Maximum load flow rates for DPCV and PICV systems include a 5% allowance for system by-passes to prevent pumps operating against a closed head.

**Note 2:** Minimum load pressure losses are those that will be achieved when all control valves are closed i.e. zero flow through fan coils. For the 4PV system the value is assumed approximately constant. For the DPCV and PICV systems pump pressure will reduce to that controlled constant at the remote sensor.

**Note 3:** The pressure loss at 50% load (i.e. 50% flow) has been calculated on the basis that at 50% flow, the pump pressure will reduce to a value 25% of the difference between the maximum and minimum differential pressures (since, due to the square law relationship between pressure and flow, a 50% reduction in flow will result in a 75% reduction in pressure loss).
System controllability: 4PV

Control of the return temperature to the heating or cooling source is poor. Under part load conditions, a 4PV will divert flow through its internal by-pass causing “low delta T syndrome”.
System controllability: DPCV

The consequence of poorly located DPCVs is that 2PVs will not operate with sufficient authority for effective modulating control of heating or cooling output. This will result in uneven temperatures within the building and may also contribute to “low delta T” syndrome.
System controllability: PICV

Integrated differential pressure regulator $\rightarrow$ preserve 2PV authority

Authority constant at partial load $\rightarrow$ low delta T syndrome avoided
Conclusions

The findings of this report show that there are clear and demonstrable pump energy savings achievable by the design of variable flow DPCV or PICV systems compared to constant flow 4PV systems.

The largest savings are achievable by PICV systems which can save 70% of pump energy relative to a constant flow system, and 30% relative to a DPCV system.
Further readings
EvoPICV
Pressure Independent Control Valve

Technical manual

Prepared by Luca Baroli
Assessment of alternative valve solutions for heating and chilled water systems

By Parsloe Consulting Ltd
3. Case study system layouts

A practical arrangement of terminal devices was decided on the basis of an estimated future demand. Figures 1, 2, 3, 4, 5, 6, and 7 show various layouts involving less study systems, including various distributions. The main parameters for each layout are summarised in Table 2.

Table 2: Design parameters for example systems

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Description</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The energy consumption of the proposed system is significantly lower than that of the existing system. The system was designed to ensure efficient energy use by optimising the layout of terminal devices and reducing energy waste. Future enhancements could include the integration of renewable energy sources to further reduce the environmental impact.

Table 3: Comparison of energy consumption

<table>
<thead>
<tr>
<th>System Description</th>
<th>Energy Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing System</td>
<td>500 kWh/day</td>
</tr>
<tr>
<td>Proposed System</td>
<td>300 kWh/day</td>
</tr>
</tbody>
</table>

References


Prepared by Luca Baroli
The Definitive Guide to Pressure Independent Control Valves

By Pettinaroli & Parsloe Consulting Ltd
Active control of room temperature

The importance of achieving an accurate equal percentage control characteristic and good valve authority becomes clear when the resulting variations in off-coil supply temperatures are considered.

When in use, the control valve forms the output part of a closed loop controller, changing its opening in response to changes in the measured room or return air temperature. In such systems it is particularly important to ensure effective modulating control of the off-coil temperature, and it is a function of the control valve to achieve this. Inaccurate control will result in heating by heating whereby the controlled temperature in the occupied space repeatedly overshoots or undershoots the set point value. This can create discomfort conditions for the occupants and waste energy.

For this reason, it is highly recommended that the PICV and its actuator deliver an accurate equal percentage characteristic.

Figure 7: Typical variations in Qmax

EFFECT OF POOR ACTUATOR SELECTION ON VALUE CHARACTERISTIC PICV (UP)

- 100%
- 80%
- 60%
- 40%
- 20%
- 0%

Value (% of PICV)

The design of heating and cooling airflow systems incorporating PICVs is particularly suitable for variable refrigerant flow systems. A guide to selecting the PICV for a given system is provided in the appendix.

Regulating Valve

What is a PICV?

A PICV is a pressure independent control valve that is used in HVAC systems to control airflow and pressure independently. It is designed to maintain a constant pressure drop across the valve, regardless of the flow rate. This ensures stable and efficient system operation, especially in variable airflow systems like VRF.
Contacts

Giorgio Simonotti – Export Manager
giorgio.simonotti@pettinaroli.email

Luca Baroli – Technical Manager
luca.baroli@pettinaroli.email

Local dealer

Arabian Controls W.L.L.
Tony M. Khoury – General Manager
info@arabiancontrols.com