PICV

Pressure Independent Control Valve

HIGH CAPACITY

FOR EFFICIENCY, STABILITY & ENERGY SAVINGS

WARREN CONTROLS

PRESSURE INDEPENDENCE

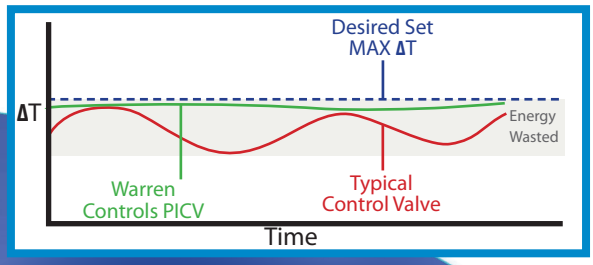
One of the factors that influence the flow of fluid through a control valve is the amount of pressure, or differential pressure, impressed across it. At any point in valve plug travel, flow through a valve will typically increase if differential pressure is raised, and decrease if it is lowered. A change in pumping pressure can therefore produce a change in rate of flow that is not related to the system

controller's output signal. By quickly raising or lowering its own resistance to flow, the differential pressure control section of the Warren Controls Pressure Independent Control Valve regulates and stabilizes the pressure drop across the control valve section. This can compensate for changes in pumping pressure resulting from pump switching or from varying flow demands in its own, or parallel flow paths.

EFFICIENCY / ENERGY SAVINGS

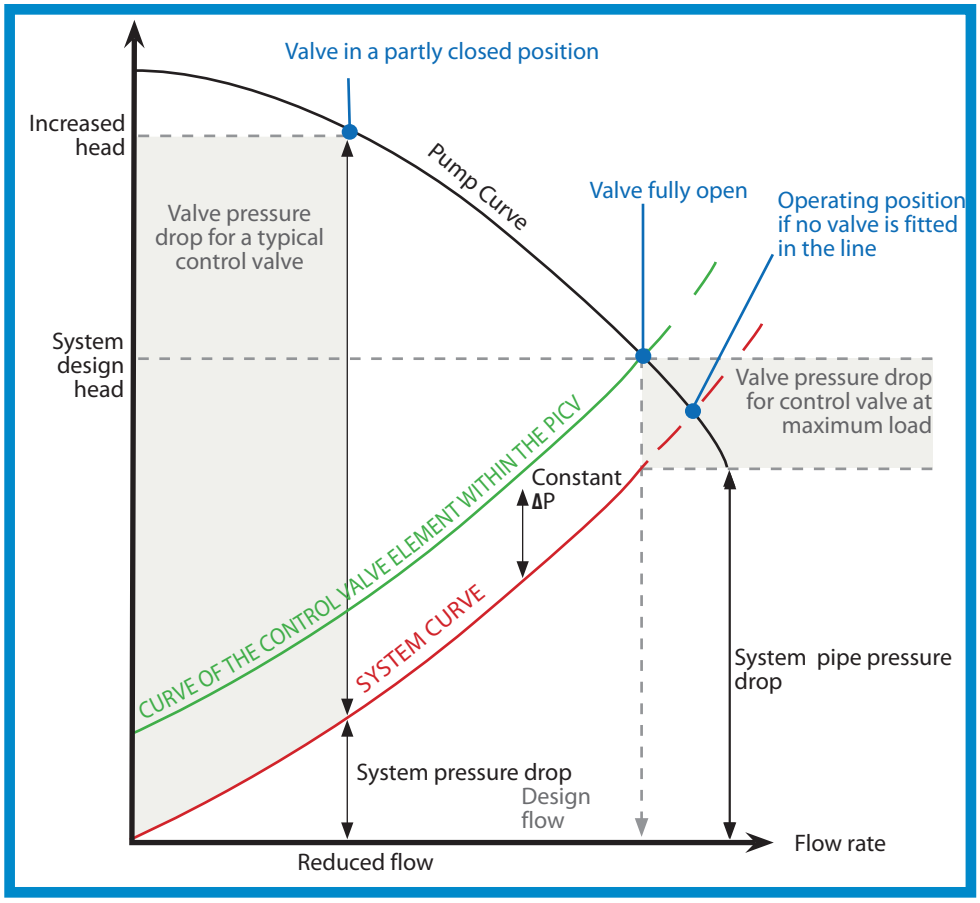
The goal in any energy transfer system is efficiency. Efficiency is achieved when the maximum allowable temperature differential is achieved across a coil or heat exchanger, and then maintained as a constant differential temperature, regardless of load and corresponding flow changes.

Today's Building Management Systems rely on this goal and develop control schemes accordingly to demonstrate maximum efficiency and energy savings. However, the complex and dynamic variables that influence this steady state are often an enormous challenge for most control systems. With the Warren Controls PICV, varying upstream and downstream pressures no longer influence this outcome. The PICV allows a building management system to measure this differential temperature and vary the control valve without external disturbances influencing flow rates. Since the goal is to reach maximum ΔT without exceeding plant specified MAX limits, any variation or deviations in control must be BELOW this limit. The size of these deviations is not only a reflection of the control performance but also energy wasted.



> Stability in the control system is enhanced when pressure independence is provided, and the control valve's installed flow characteristic remains predictable and uniform throughout the control range.

- A two-port electrically actuated control valve is requested to control the temperature on the incoming water from the Heat Exchanger.
- As the control valve throttles towards its closed position, flow will decrease and the pressure upstream of the valve will increase, hence causing changes in the pump head. As illustrated to the right:
- Changes in pump head impact the power consumption of the pumps, increasing operating costs on the district cooling plant side.
- Hence a differential pressure "control" valve is required to regulate the DP across the motorized control valve in order to offset pressure changes due this latter's throttling actions.
- The introduction of the above dual controlling elements poses two intertwined questions.



SOME CONSIDERATIONS:

When selecting a two-port control valve for an application the following needs to be taken into consideration.

UNDERSIZED VALVES:

Under-sizing a control valve, in a system, increases the pressure drop of the entire system – meaning the pumps would use a larger amount of energy simply to pass sufficient water through the system and more specifically through the control valve. However, assuming a cost no object scenario, i.e. enough water could be forced through the valve, then the accuracy of the control is at an optimal as the entire travel of the valve may be utilized to achieve the desire control.

OVERSIZED VALVES:

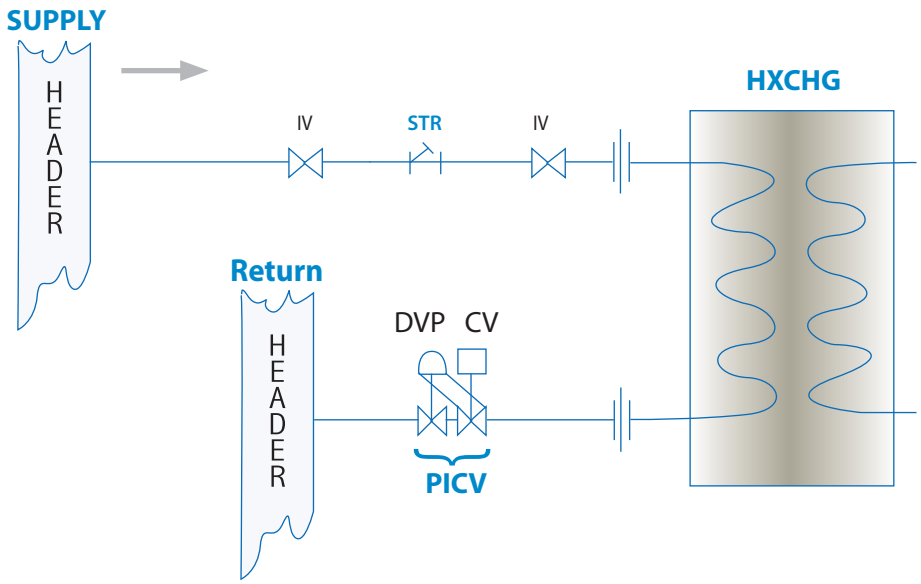
Over-sizing a control valve, in that same system, would reduce the amount of energy needed to pump the necessary flow into the system and hence reducing power consumption. However, such savings will come at the cost of a decrease in the accuracy of control, as the initial travel from fully open towards the closed position would have no effect on the control medium and therefore on the control variable. In other words, when a valve is over-sized, significant control can only be achieved when the valve is throttling in the neighborhood of its closed position. Hence, only a relatively small fraction of the valve travel is useful for control. As a consequence, small movements of the valve stem are expected to have a relatively large impact on the control medium, yielding erratic control with poor stability and accuracy.

Clearly, a trade off exists between the above two considerations; and proper sizing requires a sustainable equilibrium where a balance between control while reducing energy losses is achieved.

CONTROL VALVE AUTHORITY

A mathematical representation for how a control valve will perform in circuit. In general terms, it is a ratio for what the full load pressure drop is on the control valve with respect to the full load pressure drop of the entire circuit including the control valve.

Valve authority should be in the general range of 0.2 - 0.5. If the value gets too low, the control valve looses its rangeability where low demand control performance suffers and nonlinearities throughout the control range are more dramatic. If the value is too high, the valve may be a bit small for the job and generally is not making efficient use of energy.



IF YOU HAVE A SYSTEM THAT IS COMPLETELY CLOSED LOOP AND UNTO ITSELF, THEN ΔPRCC TRULY DOES REPRESENT EVERYTHING ELSE IN THE CIRCUIT.

HOWEVER... If the circuit is actually a sub circuit and part of a larger loop, whereby a degree of inherent pressure isolation exists from interaction with the main loop, largely due to the inherent size and capacity of the main loop, as is the case in say for a main on a district cooling loop,

THEN...ΔPrcc **may** only be calculated for elements upstream of the control valve back to the main loop as there will be no interactive influence by the control valve on the elements downstream, as would be realized on a truly closed loop system.

THEREFORE...A sub circuit of a district main can be considered open loop, and Valve Authority **may** be calculated against elements upstream of the control valve up to the supply header.

This is demonstrated in the diagram to the right, where ΔPrcc is defined as elements under the influence of the Control Valve up to the main header, upstream of the Control Valve element.

CONTROL VALVE AUTHORITY CAN BE EXPRESSED AS:

$$N = \Delta Pcv / (\Delta Pcv + \Delta Prcc)$$

where **N** = Control Valve Authority

ΔPcv = Differential pressure of Control Valve Element when under full open - full load condition

ΔPrcc = Differential pressure of 'Remaining Control Circuit' under same full load condition.

OPERATION

The control valve section is a Warren Controls industrial-grade, pressure-balanced control valve, actuated by either a high-thrust electric motor actuator or pneumatic diaphragm actuator. Both provide precise positioning of the valve closure mechanism, and respond quickly and precisely to the electronic instrumentation control signals supplied to them. A wide range of sizes, materials of construction, pressure ratings and control characteristics provides flexible configuration to meet almost any specification or system requirement. The differential pressure control section operates independently of the control valve section. It is self-powered (self-operating) and does not burden or interact with the building automation control system. Stable control of the pressure drop across the control valve enhances, indeed enables precise control of differential temperatures across the heat exchanger. This minimizes the cost of providing heating and cooling, optimizes comfort within the building's environment, and provides economic benefit to the facility providing chilled and heated water for energy transfer.

PICV: TYPICAL SPECIFICATION

The Pressure Independent Control Valve (PICV) shall consists of two functional controlling segments. The first serves as a pneumatically or electrically actuated control valve, capable of responding to a control signal from a controller that is not part of the PICV.

The second segment is connected in series with the first, and serves to sense and regulate a preset flowing differential pressure across the control valve segment.

Both segments include pressure balanced control elements of industrial quality manufactured in accordance with ISO 9001.

The Pressure Independent Control Valve (PICV) is factory assembled, complete with sensing lines and actuators, ready for field installation as a complete unit.

The Pressure Independent Control Valve (PICV) is pre-calibrated to a customer-specified set-point, and includes a means for calibration adjustment.

CONSTRUCTION:

- Valve Bodies
- Material: Cast Iron
- End Connections: 125 lb RF flange
- Trim Design: EQ% -300 series stainless steel
- Packing: Long-life Multi-Stack EPDM Lip

DOUBLE ACTING DIAPHRAGM

Control Signal:	Differential pressure from control valve, 3-6 PSIG (0.2-0.4 BARG) Nominal; 140 PSIG (10.0 BARG) Static
Spring Packing:	Preset to 5 PSIG adjustable from 3 - 6 PSIG
Manufacturers:	Warren Controls

ELECTRIC ACTUATOR

- Control Signal
- 4-20 mAdc; 0-20 mAdc; 0-10 Vdc or 0-20Vdc and floating self adjusting field selectable
- Feedback Signal: 0-10 Vdc or 0-20 Vdc
- Failure Mode: Fail Close
- Manual Override
- NEMA Type 2
- Shut Off Pressure: > 6 BARG

Notes: 2.5" through 6" Control Valves (CV) are Type 23 valve body assemblies with VM actuators. 8" CV is a Type 22 valve body with a VM actuator.

ELECTRIC ACTUATOR SPECIFICATIONS (ILEA)

Power Supply:	24 Vac / 24 Vdc, 115 Vac, 230 Vac, *must be specified at time of order.*
Power Consumption:	57 Watts
Stroke Speed:	5.5 seconds / inch of travel to 36 seconds / inch of travel, model dependent and programmable.
Control Signal:	4-20 mA, 0-20 mA, 2-10 Vdc, 0-10 Vdc
Feedback Signal:	4-20 mA, 0-20 mA, 2-10 Vdc, 0-10 Vdc
Failure Modes:	Fail-In-Place, Fail-Open, Fail-Closed, model dependent
Override:	Hand Knob enclosed in protective cover
Enclosure:	IP67, die-cast powder-coated aluminum cover with captive screws
Connections:	Cable Strain relief, two each M-20 and one each M16 to IP67. Optionally, as accessory, ½" Female NPT connections available.
Temperature Limits:	-4°F to 140°F (20°C to 60°C)
Mounting:	Vertical, Above Valve (a requirement of the PICV assembly)

DOUBLE ACTING DIAPHRAGM ACTUATOR WITH SPRING ASSIST (SERIES 2)

Control Signal:	Differential Pressure from Control Valve, 3 - 6 PSIG (0.2 - 0.4 BARG) Nominal, 150 PSIG (10.3 BARG) Max Static
Fluid:	Chilled Water Typical, Water or Water/ Glycol from 35˚F- 180˚F (2˚C - 82˚C)
Spring Pack:	Preset to 5 PSIG unless specified, adjustable from 3 to 6 PSIG
Construction:	Ductile Iron, epoxy coated, epoxy coated spring, SS components, Woven neoprene diapragm.
Temperature Limits:	Ambient 32˚F - 122˚F (0˚C - 50˚C)
Mounting:	Factory Aligned, Vertical Above Centerline of Control Valve Consult factory for preconfigured alternate orientations

VALVE BODIES

Body Material:	Cast Iron
End Connections:	ANSI 125 Lb. RF Flanges
Trim Designs:	T23 - Single Seat Cylinder Balanced, ANSI Class IV Leakage T22 and 472 - Double Seat Balanced, ANSI Class III Leakage
Trim Material:	300 Series Stainless Steel Fluoraz Seal (T23)
Fluid:	Chilled Water Typical, Water or Water/Glycol from 35˚F- 180˚F (2˚C - 82˚C)
Trim Limits:	MAX Flowing Differential Pressure, 150 PSIG (10.3 BARG)
Packing:	Long-Life Multi-Stack EPDM Lip Packing for Water / Water-Glycol Service

Weights

434 lbs.

PICV-T23-472-SS-600
PICV-T23X-472-SS-600

645 lbs.

PICV-T22R2-472-SS-800
PICV-T22-472-SS-800

PICV SIZING AND SELECTION

While it may be common in many tempered water loops to simply size valves on pipe size, all factors should be considered. Static pressure, close off pressure, flowing differential pressure, MIN and MAX flows and temperature to name a few. The Warren Controls PICV has a Rangeability of 50:1, meaning that good control performance can be achieved when the minimum flow requirement is as low as 1/50 of the maximum flowing GPM. Simply identify the desired Set Differential Pressure to identify Model and Size by Maximum Flow. Assuming the Minimum Flow is within 1/50 of the Maximum, the proper choice has been made.*

6" REDUCED PORT (2-Sizes)	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	476	550	615	674
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	30.03	34.7	38.80	42.52

6" STANDARD PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	624	720	805	882
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	39.37	45.42	50.79	55.65

6" REDUCED PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	546	630	704	772
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	34.45	39.75	44.42	48.71

6" SUPER PORT (Extended Stroke)	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	727	840	939	1029
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	45.87	53.00	59.24	64.92

8" REDUCED PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	1031	1190	1130	1457
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	65.05	75.08	83.91	91.92

8" REDUCED PORT (2 Sizes)	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	901	1040	1163	1274
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	56.84	65.61	73.37	80.38

8" STANDARD PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	1178	1360	1521	1666
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	74.32	85.50	95.96	105.11

10" REDUCED PORT (2 Sizes)	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	1273	1470	1644	1800
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	80.31	92.74	103.72	113.56

10" REDUCED PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	1455	1680	1878	2058
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	91.8	105.99	118.48	129.64

10" STANDARD PORT	SET DIFFERENTIAL PRESSURE (PSIG)			
	3	4	5	6
	MAXIMUM FLOW (GPM)			
	1663	1920	2147	2352
	SET DIFFERENTIAL PRESSURE (BARG)			
	0.21	0.28	0.34	0.41
	MAXIUMUM FLOW (LPS)			
	104.92	121.13	135.45	148.39

***NOTE:** The maximum differential pressure across the entire PICV is approximately 2 x (Set Differential Pressure)

PICV_OV_RevA_0318

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