With Low Delta T, Where Does The Excess Flow Go?

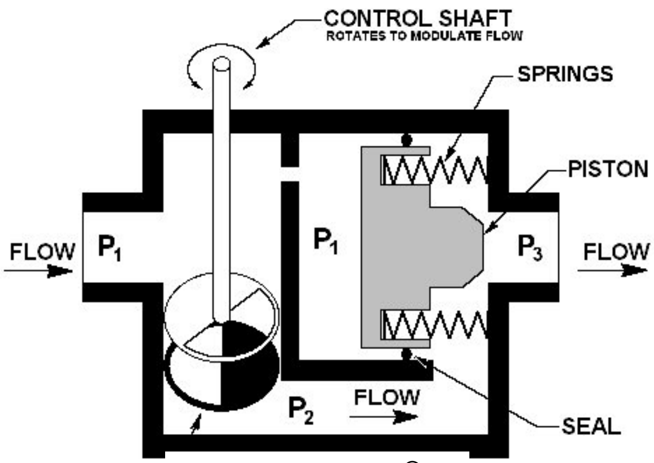
Abstract

Excess flow and low part-load delta T, in large distributed hydronic systems, leads to energy waste and limited available plant capacity. Pressure-independent modulating DeltaPValves® are designed to replace the conventional two-way control valve and a balancing valve combination. DeltaPValves® minimize flow, raise delta T, and reduce energy consumption while delivering the full installed capacity of the plant. This paper highlights sources of energy waste in a central plant or looped chiller system caused by poor flow control and heat transfer at the terminal units.

Cooling Coil Heat Transfer

Conventional commercial-quality control valves in HVAC system perform poorly in low flow conditions and with high pressure differentials. Most conventional valves have poor turndown capability and will tend to "bang-shut" or create unsteady flow, especially in low load conditions. With high pressure differential, globe valve are known to lift off their seats. With or without a change in the cooling load, all conventional control valves "hunt." Some are much worse than others. Flow varies as the hydraulic profile changes, pumps are turned on and off and change speed, and valves open and close to address the demand for flow.

Pressure-independent DeltaPValves® have an internal piston and spring that regulates the differential pressure across the control surface. Rangeability is 100:1. Flow is steady and always stays tuned to the cooling load. Steady flow improves heat transfer effectiveness by minimizing overcooling and undercooling as well as fluctuation across the turbulent/laminar boundary condition in the cooling coil. With DeltaPValves® at the terminal units, the system does not "hunt" or overreact to changing cooling loads and system pressures.



DeltaPValve®

P_1 and P_3 are system pressures, P_2 is set by the springs acting on the piston.

The piston and springs set P_2 to maintain a constant ΔP (P_1-P_2) across the control surfaces. Flow remains constant over the pressure independent range (typically 5-60 psi).

DeltaPValves® have an adjustable Cv with infinitely variable flow setting. The control shaft rotates to modulate flow through the valve.

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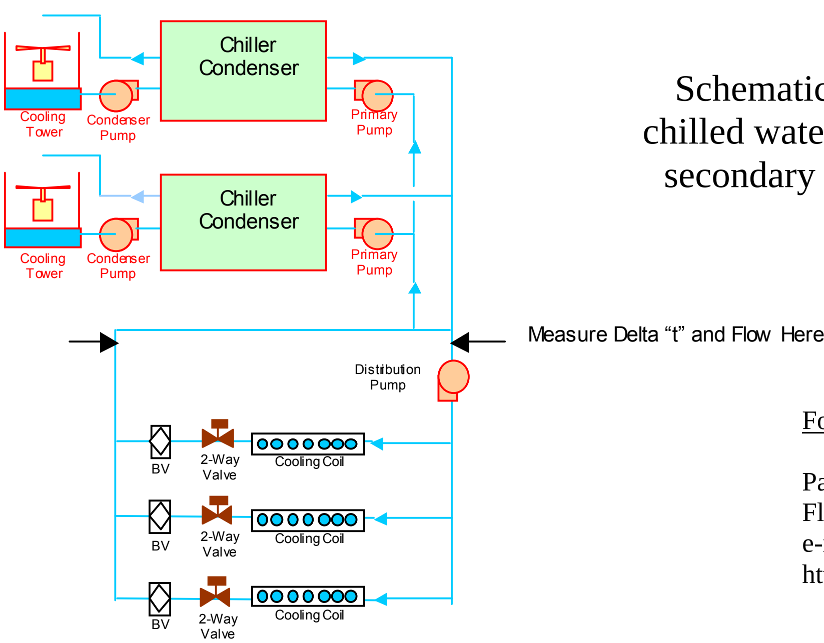
Excess Flow at the Plant or Through Decoupled Bypass Loops

It is obvious that minimizing flow and raising delta T in all load conditions will reduce pump horsepower and energy consumption. What is less obvious is the energy savings at the central plant or at the chiller stations in the loop. Excess flow must be processed at the central plant or through a decoupled bypass when delta T is below design. There are three alternatives commonly used to process the extra flow.

1) Overflow the "on" chillers. This overworks the chillers and moves their operating point off the best efficiency. Chiller is de-rated for lower delta T. Central plant maintenance, depreciation and energy expense all rise.

2) Pump through "dead" chillers or decoupled bypass loops. This blends the (warm) chilled water return with (cool) supply raising the temperature of the water distributed to the loop. Energy is lost where the mixing occurs, due to the irreversibility of mixing. This also reduces the temperature differential between entering air and water at the terminal units (air handlers, fan coils, etc.). Terminal equipment is overworked and energy wasted at the loads.

3) Turn on additional chillers.[1] While this maintains low chilled water supply temperature to the facility, it requires operation of excess chiller and accessory equipment, again wasting energy. The most efficient piece of equipment is the one not running.



Schematic of a conventional chilled water plant and primary / secondary distribution system

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[1] This alternative is analyzed with Flow Control Industries Energy Manager's Quick Savings Guide based on a typical 4,000 ton central plant with multiple electric centrifugal chillers. Gas power chiller systems and thermal energy storage also suffer from low delta T in the distribution.

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