

Presenting Intelligent Iterative Control: PID Replacement for Setpoint Control

Limits of designing with line-sized chilled-water valves

Editor's note: This is the third part in a three-part series.

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Although designing chilled-water distribution systems with line-sized control valves reduces pump-head requirements and, thus, reduces both first costs and energy costs, there are restrictions and limitations when such a design path is taken. One of the most critical of these concerns the pressure differential across valves. I recommend that systems be designed so that the pressure across a control valve does not exceed double the design pressure drop through the load it serves. This means that if a cooling coil is rated for a pressure drop of 10 ft at full flow, the distribution system should be designed so that the valve serving the coil has a differential that remains below about 20 ft. As an example, consider the variable-primary-flow distribution system shown in Figure 3.

In this centralized pumping scheme, chilled water is pumped through the chillers and into the distribution network. If the distribution system is large, then loads near the chillers (such as loads

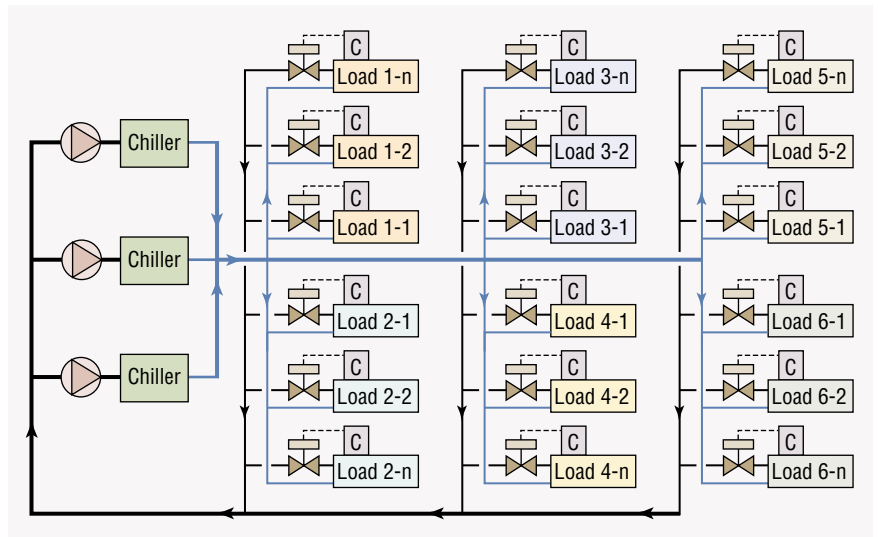


FIGURE 3. A variable-primary-flow distribution system.

1-1 and 2-1) may be subjected to large supply-header and very low return-header pressures at high-flow conditions. These high pressures may be necessary

to transport water to the farthest reaches of the system. Thus, if iterative control with line-sized valves were employed, the loads close to the chillers could become

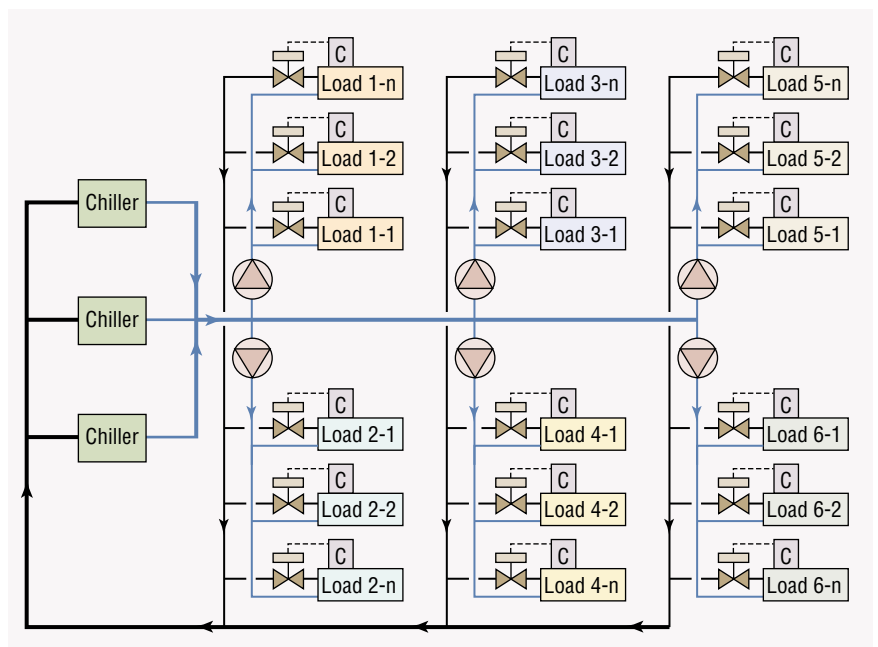


FIGURE 4. Alternative configuration using distributed pumps.

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uncontrollable at high-flow conditions.

To avoid this potential condition, an alternative configuration using distributed pumps (Figure 4) should be considered. In this pumping scheme, pumps are

in Figure 4 is more energy-efficient, in addition to being more controllable at all flows.

Readers may notice that the variable-primary-flow configurations in figures 3

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placed at the distribution mains, rather than centralized at the plant. In other configurations, it may be advantageous to employ a primary-booster pumping scheme. Because the pressures across the valves in Figure 4 are lower (on average) than those in Figure 3, the configuration

and 4 do not employ a bypass valve for low-flow conditions. When intelligent iterative control is employed, a bypass valve usually is unnecessary, as the intelligent, network-based valve control can ensure a minimum level of flow through the loads at all times a chiller is operating.

BENEFITS OF INTELLIGENT ITERATIVE CONTROL

The benefits of replacing PID control with the type of iterative-control scheme described in this series of columns have been shown to include a reduction in distribution-pumping-energy requirements to less than one-half of conventional distribution-energy requirements. Furthermore, average valve-repositioning frequency can be reduced from one-tenth to a hundredth of what is required conventionally. In addition, much greater control stability under nearly all operating conditions usually is achievable. Finally, when coupled with demand-based control in plant and distribution systems, this control is far more effective, with the opportunity to ensure that all loads are satisfied all of the time.

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