

Variable Water Flow Pumping for Central Chilled Water Systems

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The primary issues of central chilled water systems are: the central distribution versus the distributed distribution, the primary secondary versus the primary only, and the constant flow versus the variable flow. It is well known that the distributed systems use much less pump energy than the source distributed systems. However, the source distribution systems are still in use because they are easy to operate.

As an energy conservation measure, the primary secondary (PS) pumping was developed in the last 20 years to replace the constant pumping systems. It decouples the building circuit, where the chilled water flow varies with the building load, and the chiller circuit, where the constant water flow is maintained. The PS system has been designed for new facilities and retrofitted to most existing facilities. The PS system has been found to decrease the pump energy and improve the central plant operation reliability, however, the system was developed based on an outdated assumption: *reliable chiller operation requires constant chilled water flow through an evaporator*. Chiller technologies have been improved significantly since the PS was introduced. The strategically placed sensors and real-time response of today's control system allow the chiller to perform its primary function--producing cold water--*even when the evaporator flow rates vary*.

Advances in the chiller technology present new energy conservation opportunities for the chilled water loop design and control. Advantages and disadvantages of the variable water flow systems have been researched and the design issues of the variable chilled water flow through chillers have been discussed. It was concluded that the varying chilled water flow saves pump energy. The impact of the variable water flow on the chiller performance was investigated and the measured results showed higher evaporative temperatures when variable water flow was applied. Varying chilled water flow through an evaporator also decreases the compressor power consumption. However, the proposed variable water flow systems do not allow chilled water by-pass chillers. However, chilled water by-pass is often needed under partial load conditions.

A new variable water (VW) system was proposed and design, operation, and control issues were discussed. As a result general analytical models of pump energy and evaporative temperature were developed. Numerical results were provided for typical chiller systems. The VW systems consume considerably less pump and compressor energy than the primary secondary (PS) systems under partial load conditions for most existing chillers. The VW system consumes less compressor energy since it results in higher refrigerant temperature in the evaporator. The VW systems also have the decoupling capability of the primary and secondary pumping systems.