Single-Chiller Plants

System Description

Single-chiller systems are the most basic chiller plants to design and operate. The chiller is sized to meet the design load and provides all the cooling in the building. Variable flow systems are also possible.

Chilled Water Loop

The chilled water loop circulates through the chiller and then throughout the building. Most single chiller designs are constant flow with three-way valves at the terminal units. A single main pump circulates water through the chiller and the building

System Parameters

A single-chiller system can be sized for the block cooling load, but offers no redundancy.

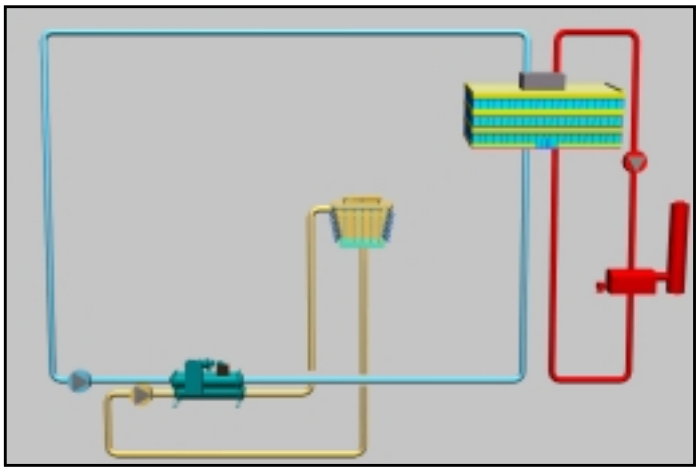
Typical chilled water supply temperatures range from 42 to 45°F, with 44°F being the most common. If a 10°F delta T is used, the chilled water flow is 2.4 U.S. g.p.m. per ton.

Condenser water supply temperatures range from 80 to 90°F, with 85°F being the most common. The condenser water delta T is typically 10°F, which equates to 3.0 U.S. g.p.m. per ton.

Chiller Selection and Sizing

Any kind of chiller can be used. Air-cooled chillers are common since they are inherently simpler to design and operate and require no cooling tower.

Since the chiller capacity must equal the building design load, it is oversized for most of the operating hours. (The bulk of the operating hours usually occur around 50% of the design load.) The chiller must have good unloading characteristics and strong part load performance. Dual compressor chillers can accommodate the operating requirements while providing redundancy.



Condenser Water Loops

Condenser water loops are required for water-cooled chillers only. Each chiller typically gets its own condenser water pump sized to provide the correct flow for the chiller. Cooling towers are used to reject heat in the condenser water to ambient. Water-cooled chillers are more efficient than air-cooled chillers because they operate with a smaller compressor lift.

Cooling towers may be sized and dedicated to each chiller, or a common cooling tower plant may serve all the chillers.

System Pros

- Straightforward to design and operate.
- Dual-compressor chillers provide redundancy, wide operating range and strong part load performance.
- Chillers can be any size or type.
- Small mechanical room, especially if chillers are air cooled.

System Cons

- Single-chiller plant offers no redundancy.
- Operating chiller at light loads is inefficient and puts undue wear on equipment.

Energy Considerations

Since the chiller size in a single-chiller system is matched to the design load, it is oversized most of the time. Part load performance is generally poorer than full load, so the chiller plant is less efficient than in other designs. Moreover, the condenser water pump is sized for design load and also oversized most of the time. The following are some considerations outlined in ASHRAE Std. 90.1-1999. The numbers in brackets refer to Std. 90.1-1999 sections.

- Energy efficiency tables for HVAC equipment (6.2.1).
- Equipment must be scheduled off automatically during unoccupied hours (6.2.3.1).
- Air- or water-side economizers are required. There are several exceptions to this rule, particularly when dealing with heat recovery (6.3.1).
- Reheat is allowed if at least 75% of the energy for reheat comes from on-site energy recovery (templifiers).
- Hydronic systems with a system pump power that exceeds 10 hp must employ variable flow and isolation valves at each terminal device. The system must be able to operate down to at least 50% of design flow. (6.3.4.1)
- Individual pumps over 50 hp and 100 ft. head must have VFDs and consume no more than 30% design power at 50% design flow (6.3.4.1).
- Supply temperature reset is required for hydronic systems larger than 300 mbh. Temperature reset is not required if it interferes with the proper operation of the system, i.e.: dehumidification (6.3.4.3).
- Fan motors larger than 7½ hp on cooling towers must either have VFDs or be two speed. A control system is required to minimize power usage (6.3.5).
- Hot gas bypass for refrigeration systems is permitted, but has strict limitations (6.3.9).

A thorough explanation of the Standard is beyond the scope of this document. The designer should have access to the Standard and a complete understanding of its contents. The ASHRAE 90.1-1999 Users Manual is also very helpful. ASHRAE considers Standard 90.1-1999 a high-profile standard and continuously updates it.

Typical Applications

The simple design of a single-chiller system makes it attractive for small-to-medium sized plants. Lack of redundancy and demand for a wide performance range limits its application in larger systems.

Common applications include:

- Small Office Buildings
- Schools
- Industrial

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