Fundamentals of Chiller Plant Design

The keys to superior chiller plant design

DAIKIN LEARNING
ADVANCING THE INDUSTRY

1 Hydronic Design

Heating, Ventilating and Air Conditioning (HVAC) systems exist to provide the building occupant with a safe, comfortable environment. HVAC is the science of moving energy from where it is not required, to where it is. The energy is transported in several fluids including air, water and refrigerant.

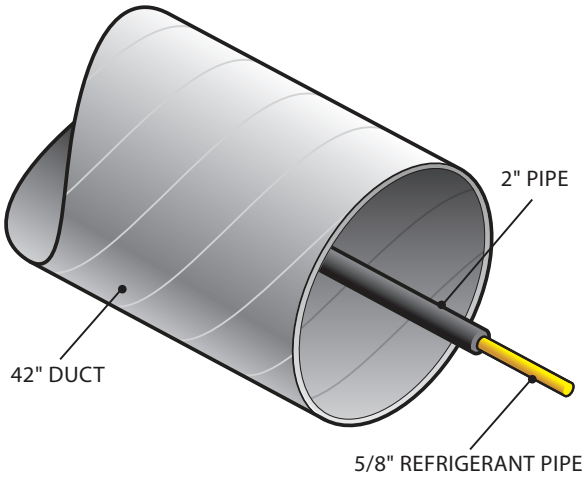

Figure 1.1
Energy Transfer in Common Fluids

Figure 1.1 shows that the same amount of energy can be transported in a 42 inch duct, a 2 inch water line or a 5/8 inch liquid refrigerant line. Using air as a transport medium allows the designer to simultaneously manage Indoor Air Quality (IAQ) issues by means of ventilation and energy transfer.

Refrigerant-based transfer is the fundamental premise of Variable Refrigerant Volume (VRV) systems. It offers outstanding transport properties on a pound-for-pound basis. Hydronic (water) systems offer excellent transport properties in a safe, commonly available fluid. It is the universal choice for large HVAC system design.

Chapter 1 will cover the basics of piping design. While this text is focused on chilled water systems for cooling, the piping basics are the same for both heating and cooling.

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Basic System

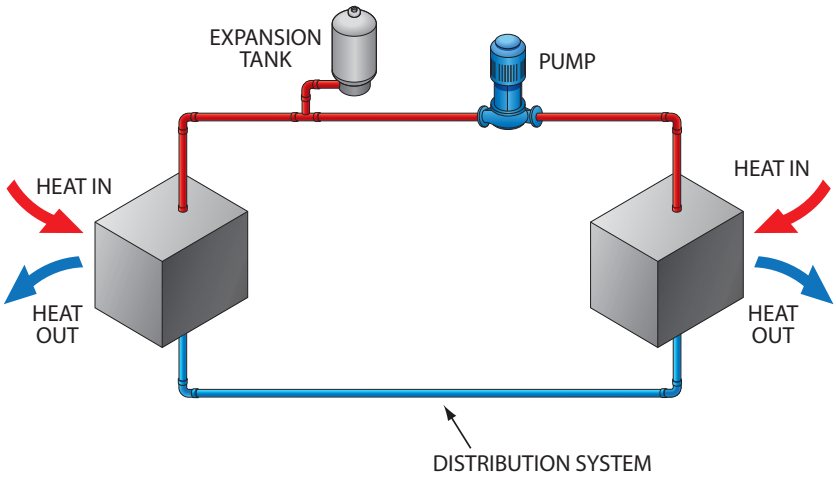

Figure 1.2
Basic Hydronic System

Figure 1.2 shows the basic closed hydronic system. This is true for either a heating or cooling system. For the most part (other than start up and shut down stages), the energy entering the system is equal to the energy leaving the system. The main components are:

- Source
- Loads
- Distribution System
- Pumps
- Expansion Device

Source

A source is a point where heat is added to or removed from the hydronic system. For the system to be in a steady state, the source capacity must meet the load plus any losses. Heating sources are typically heat pumps, boilers, heat exchangers, solar collectors or heat recovery devices. Cooling sources are typically electric vapor compression chillers, gas driven vapor compression chillers, absorption chillers or heat exchangers to a cold source (e.g. deep lake water, etc.)

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Loads

For HVAC systems, a load is the building's heating or cooling requirements. Depending on the season, use, time of day, etc. the loads can be either heating or cooling. It's common for both heating and cooling loads to exist simultaneously in different parts of the building. Loads can be added to the hydronic loop by air handling units, fan coils, unit ventilators, heat exchangers, and so on.

Figure 1.3
Typical Terminal Units

Distribution System

The distribution system consists of a piping system that connects the loads and sources, and a pumping system to move the water through the system.

Pumps

Pumps are used to move water throughout the distribution system – from the loads to the sources and back again. Depending on the design, they can be constant or variable flow. In an HVAC system, the pumps use a significant amount of energy since they operate whenever the HVAC system is working. Careful design of the pumping system can save a significant amount of energy on an annual basis.

Expansion Device

As the water in the system changes temperature, it expands or contracts. The expansion device provides a place for the expansion to occur, so that the hydronic system is not damaged.