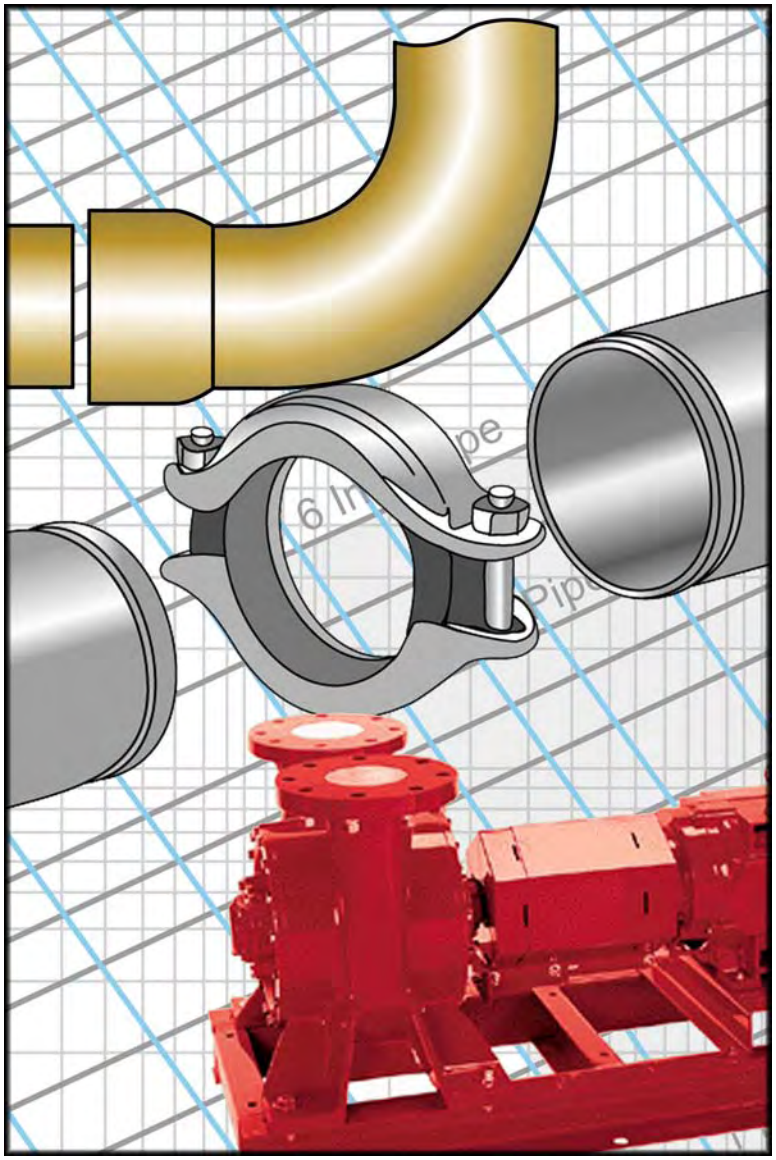
Carrier

Turn to the Experts.℠



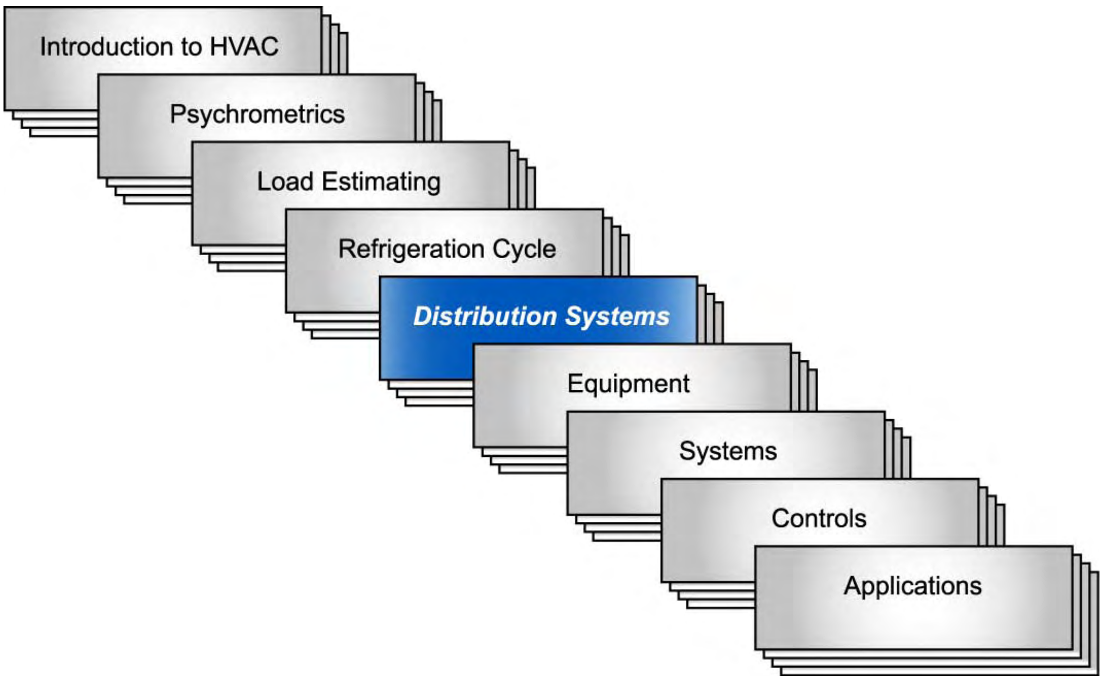
DISTRIBUTION SYSTEMS

Water Piping and Pumps

Technical Development Program

Technical Development Programs (TDP) are modules of technical training on HVAC theory, system design, equipment selection and application topics. They are targeted at engineers and designers who wish to develop their knowledge in this field to effectively design, specify, sell or apply HVAC equipment in commercial applications.

Although TDP topics have been developed as stand-alone modules, there are logical groupings of topics. The modules within each group begin at an introductory level and progress to advanced levels. The breadth of this offering allows for customization into a complete HVAC curriculum – from a complete HVAC design course at an introductory-level or to an advanced-level design course. Advanced-level modules assume prerequisite knowledge and do not review basic concepts.



Water piping and pumping is a fundamentals topic of HVAC design. The correct layout, selection and sizing of the piping system and associated hydronic components is required to properly deliver chilled and hot water as required to maintain comfort conditions. Piping connections at various equipment are covered, along with piping arrangements for chilled water systems. Pump basics, pipe sizing, and a pump selection example complete the TDP.

Printed in Syracuse, NY

CARRIER CORPORATION
Carrier Parkway
Syracuse, NY 13221, U.S.A.

Table of Contents

Introduction

In this TDP module we will cover major topics associated with chilled water piping, and to a limited extent, hot water piping. We will discuss the three types of piping systems and the four basic piping distribution designs used to supply and return water to HVAC hydronic equipment.

There are important components and accessories that are required to complete a water piping system. These include valves, tanks, and air eliminators. We will examine these system components and define their role in the total hydronic system.

After examining some typical piping hook-ups to commercial HVAC equipment, we will diagram and discuss popular piping arrangements, such as primary secondary and primary variable flow. We will then discuss a popular pipe-sizing tool from a noted pump manufacturer that streamlines the sizing process. We will also examine types of water pumps used in HVAC systems and their characteristics and applications.

Upon completion of this TDP, the reader should feel comfortable identifying, selecting, and applying the major components of water piping systems.

Types of Piping Systems

Before piping design can be discussed in detail, you must first have an understanding of the three basic types of piping systems: closed-loop, open-loop, and once-thru.

Closed-Loop (Evaporator)

In a closed-loop piping system, the water is contained within a closed piping system, or loop, through which it circulates. While there may be some nominal contact with the air depending on the type of tank used, the system is considered closed to the environment. Typically, closed-loop systems are chemically treated to control corrosion, scale, slime, and algae within the piping but their chemical treatment requirements typically are not as extensive as an open-loop.

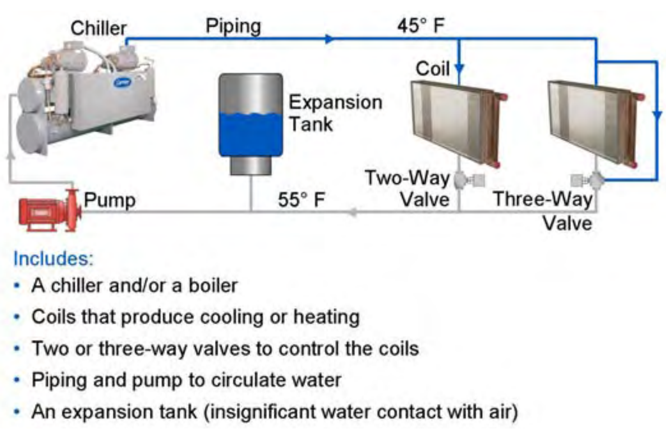


Figure 1

Example of a Closed-Loop Piping System

Open-Loop (Condenser)

In an open-loop piping system, the water is in constant contact with the air and the system is therefore open to the atmosphere. A typical example of an open-loop system is a recirculating condenser water system with a cooling tower where the water is circulated through the cooling tower, sprayed over the tower media surface, collected into the tower basin, circulated through the condenser, and then sent back through the cooling tower.

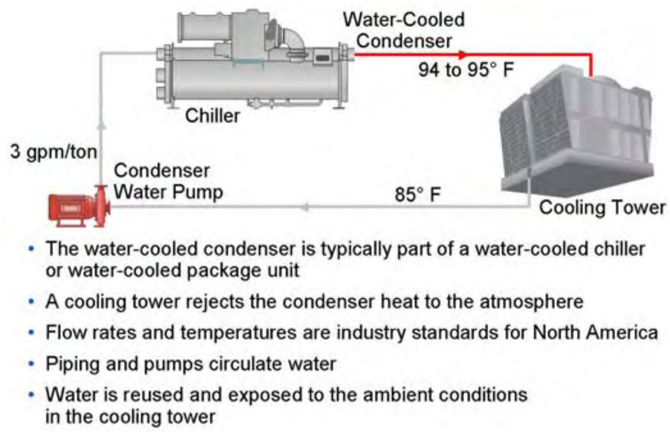


Figure 2

Example of an Open-Loop Recirculating System

Once-Thru

In this type of system, water passes through the system once and is then discharged. An example of a once-thru system would be a chiller with river water piped into its water-cooled condenser. The rejected heat from the condenser is introduced back into the river, which is not always acceptable from an environmental perspective. In general, once-thru systems that use "city" water are not allowed because they use excessive amounts of water.

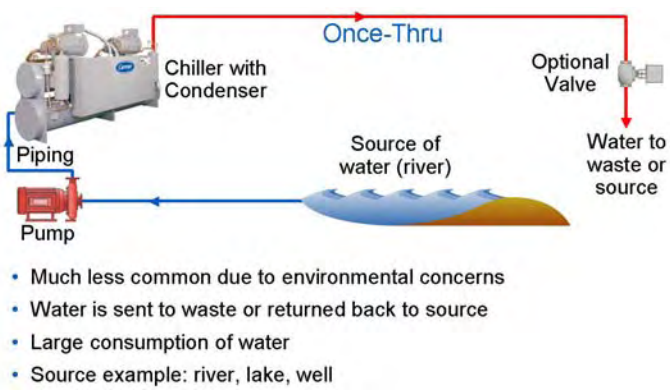


Figure 3

Example of a Once-Thru System

Pipe-sizing methods

are virtually the same for all three types of systems, however there are differences in friction loss due to expected corrosion rates in the pipes. Hence pipe-sizing charts differ between open and closed-loop systems. A once-thru system is considered an open-loop system, but typically does not get any chemical treatment like an open system does. But because river water may have more contaminants, the open-loop tables should be used, and may be conservative.

Water Distribution Systems

There are four main types of water distribution systems. They are defined by the number of pipes used in the system – 1-pipe, 2-pipe, 3-pipe, and 4-pipe. While this TDP will discuss primarily chilled water and condenser water system piping system design, it is important to understand the evolution from 1-pipe into the other three systems, all of which are used for heating as well as cooling.

1-Pipe Systems

A 1-pipe water distribution system is a system that has a one main pipe looping around the building and then returning.

1-Pipe System Uses

Since 1-pipe systems are typically only used for heating, the supply and return are shown connecting to a boiler instead of a chiller.

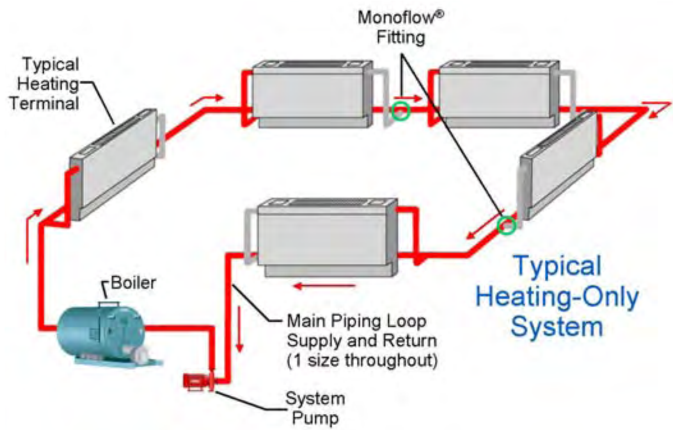


Figure 4

1-Pipe Distribution System

This pipe is both the supply and return main. Its size is constant throughout, and all of the water in the system flows through it feeding one or more zone heating terminals.

A small amount of water is induced to leave the main at each riser by the use of a special flow fitting used on 1-pipe systems, sometimes referred to as a "monoflow" fitting. These fittings create a pressure drop in the main equal to or greater than the pressure drop through the riser, runout, zone terminal unit, and return piping.

Control of flow rate to the zone terminal units in a 1-pipe system is often difficult to achieve. The pressure drop from the point where water leaves the main to where it returns is small and small changes in resistance in this line result in large changes in flow rate. As a result, many 1-pipe systems avoid flow rate control at the zone terminals and achieve capacity control by regulating airflow over the zone terminals instead.

History of 1-Pipe Systems

The 1-pipe system has been used for many years in residential and smaller commercial buildings. It has been used as a hot water distribution system and seldom, if ever, for the distribution of chilled water.

Some advantages of the 1-pipe system include the simple design of the system that requires one pipe size. This simplicity of design leads to easy installation and low installed cost.

However, 1-pipe systems have several disadvantages. The pumping head is generally higher than that in other systems because of the resistances occurring in series. That means the pump and pump energy is larger than other distribution systems of comparable size.

The change in water temperature as the water moves through the system (the water gets colder after each successive terminal because of mixing) creates the possible need of larger units at the end of the main, which will complicate the selection of the zone terminal units and add cost due to oversized units near the end. Also, at part load, the end unit may be over or under capacity.

In order to keep the pressure loss through the unit coils low, the water velocity through the coils must be kept low. This results in coils with large tube diameter, a greater number of tubes in parallel, or larger coils than used with other distribution systems. Therefore, a physical space and terminal cost penalty exist when a 1-pipe system is used.

The 1-pipe system is poorly suited to chilled water distribution for several reasons. The water quantity used in chilled-water systems is usually considerably higher than that used for heating because the unit coils work on smaller temperature differentials in the cooling mode than in the heating mode. In order to economically accommodate higher flow rate, zone terminals used for chilled water would need to be redesigned so they are not prohibitively large, expensive, or space-consuming.

2-Pipe Systems

The 2-pipe water distribution system is used with both heating and cooling equipment containing water coils. It is equally useful for room fan coil units and medium or large central air handlers using combination hot water and chilled water coils. The 2-pipe system can be used to distribute either hot or cold water, or alternate between the two. The same piping is used for both heating and cooling so there must be a definite outdoor temperature, which is called the "change-over temperature," or some other indicator of building load, at which point the hot water in the piping is replaced by the chilled water and vice versa.

Some 2-pipe fan coil units are equipped with electric heat in addition to the heating capability of the hot water coil. This "touch up" electric heat can be used if heating is required for a fan coil but the system is still not changed over to the heating mode.

2-pipe system changeover

takes time and normally is done seasonally.

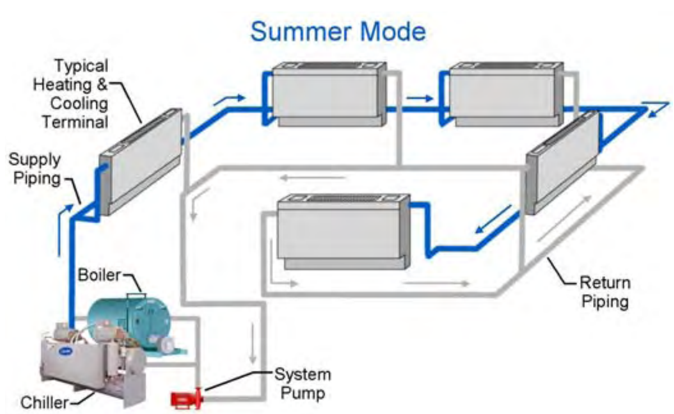


Figure 5

2-Pipe Reverse Return Distribution System

There are two forms of 2-pipe water distribution systems in common use: 2-pipe direct return and 2-pipe reverse return. Direct and reverse return will be covered later.

In a 1-pipe system, the supply and return main is the same pipe. The quantity of water flowing through the main is approximately constant and the main is built of one diameter pipe throughout its length. On the other hand, in the 2-pipe system, the supply and return mains are separate pipes and water leaving the supply main goes into the return main. As water leaves the