HVAC - Hydronic Systems

An Online Continuing Education Course for Engineers

Course Number: HV-3009

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Introduction

The science of heating and cooling with water is known as hydronics. Through years of advancement in technology, it is believed that water is still the most practical, economical, and ecologically safe heat transfer medium. The term hydronics should not be confused with hydraulics, which is the study of fluids in motion or at rest. The scope of this presentation on hydronics is to discuss heating and cooling systems, utilizing water, with their various components, maintenance, and testing, adjusting, and balancing (TAB).

Today's hydronic system can best be thought of as a heat transfer machine, large or small, where a heat transfer medium is used to carry heat to or from an area in accordance with the controls installed. Depending on the needs of the occupants, structure, and codes, the versatility of the hydronic system is limited only to the imagination of the person designing the system. A few basic fundamentals need to be learned before a person can do virtually anything desired in the heat transfer ability of a circulating water or hydronic system.

Whether the system is in a large multistory building project supplied by a central mechanical plant, or a small residence, the same basic fundamentals will still apply.

Purpose of Heating and Cooling Systems

The most basic objective of any heating and/or cooling system is to provide occupants with comfortable spaces so they may live, work, and perform well.

Normal body temperature is 98.6°F. Food and other items we eat or take into our bodies is converted into energy in the form of heat that maintains the body's temperature, so this heat must be dissipated or taken away. With a body temperature of 98.6°F, it is well noted that a comfort heating system does not warm us up. All it does is adjust inside conditions so the rate of body heat dissipation makes a person feel comfortable.

If heat is dissipated too fast, occupants feel cool; too slow, they feel hot and perspire. When air temperature and humidity are so high the body cannot rid itself of the heat fast enough, steps must be taken to cool and dry the air for comfort.

Bodies lose heat in three ways: radiation, evaporation, and convection. A warm body (human, steel, wood, plastic materials, etc.) loses heat to other surrounding bodies that are at lower temperatures. When standing next to a heated oven or out in the sun with no wind on a hot summer day, a person feels the heat radiated away from those hot objects until it hits the surface of their body and then absorbs it. This is radiation.

Evaporation mainly takes place through breathing but is rapidly increased as perspiration on the skin is introduced by overheating. The evaporation of this moisture on the skin causes a cooling effect because heat is taken away from the skin to change water into vapor.

Convection is the effect of moving air over a body and taking with it the heat at the surface of the body.

Outdoor Conditions

Since each outdoor temperature is indicative of a different rate of heat loss, a heating system must be capable of operating at more than one rate to be effective and efficient. With a given indoor temperature, each outdoor temperature results in a different temperature which controls the rate of heat loss. Balancing the requirements of the various rates of heat loss calls for different rates of heat supply as the outdoor conditions may require.

Basic Hydronic Systems

Heating

A variety of heat sources and heat radiation are used for differing conditions of application. The source of heat may be from a boiler where the combustion of fuel in many forms provides the heat or from a converter wherein the heat of steam is transferred to the water. Both of these systems are shown in Figures 1 and 2.

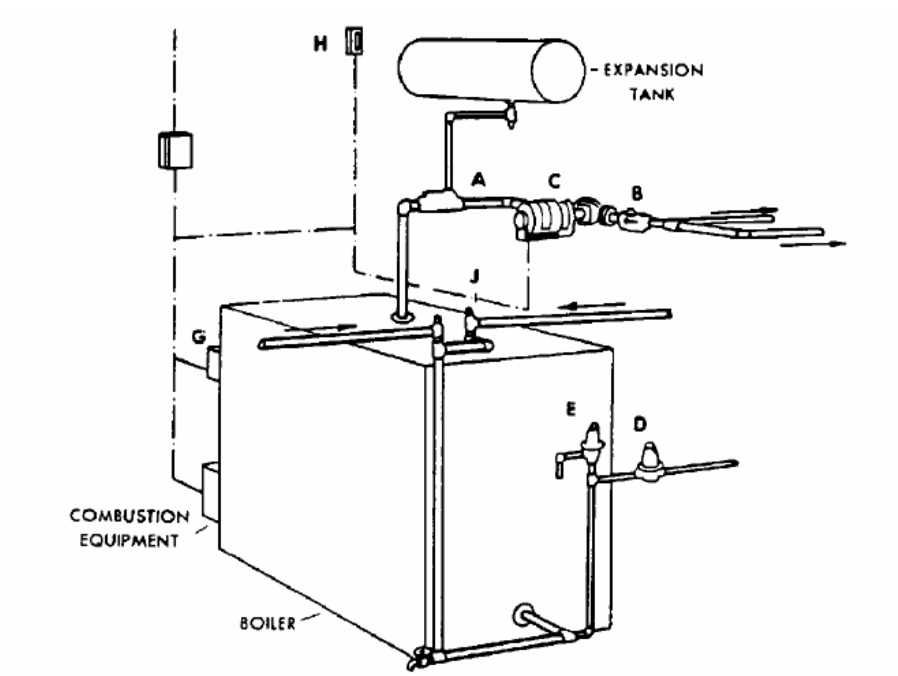

Figure 1. Heat Supplied by Boiler.
Illustration courtesy of Dunham-Bush, Inc.

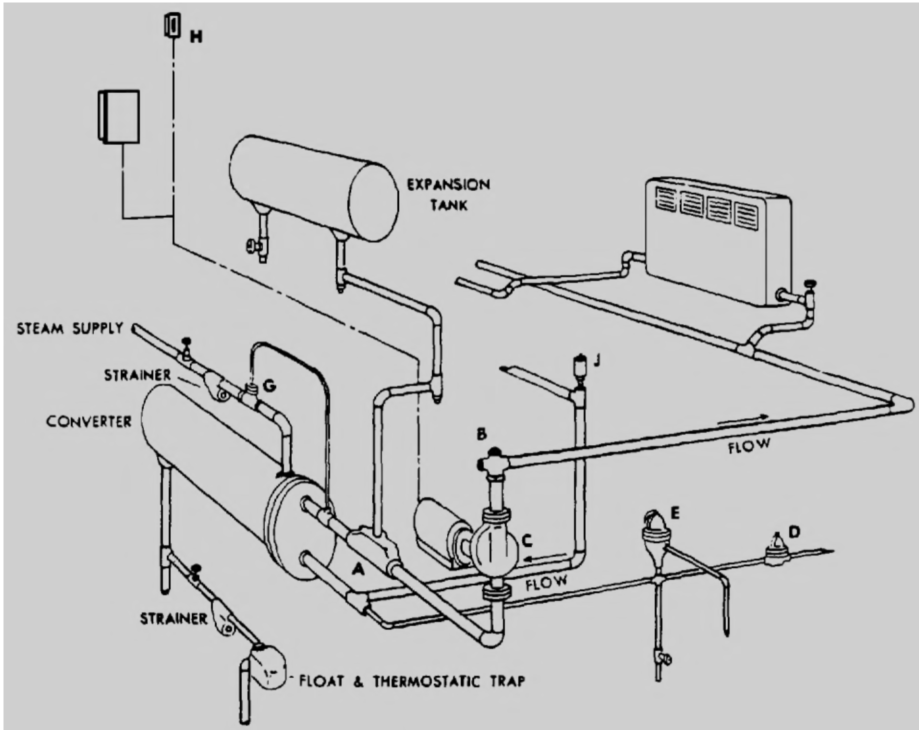

Figure 2. Heat Supplied by Converter.
Illustration courtesy of Dunham-Bush, Inc.

As described in Figures 1 and 2, the main water circuit is from the boiler or converter, through the air separator (A), and flow control valve (B), to the radiation, and back to the boiler or converter.

The flow control valve opens when the pump starts the water's movement and closes when it stops. The closed valve prevents gravity flow of water through the system.

Circulation of water at varying temperatures is controlled in one of several ways to maintain a proper room temperature level. Combustion and pump operations are automatically controlled while a room thermostat is used for control of room temperatures.

Pressure may be raised in hydronic systems to prevent water from steaming so higher temperatures may be obtained, making optional system temperatures obtainable. Where water is used for both heating and cooling, lower water temperatures and open expansion tanks are commonly used.

Cooling

For cooling, a system may be independent of a heating system or combined with one. Such a case of combination would be heating by baseboard or finned pipe units, and cooling by means of a central air-conditioning unit or individual combined heating and cooling units.

Individual fan coil units that operate for heating and cooling may be installed so the same piping is used for both. The arrangement that is more desirable depends on the requirements of the particular installation, including cost considerations. Figure 3 shows an example of a hydronics heating and cooling system.

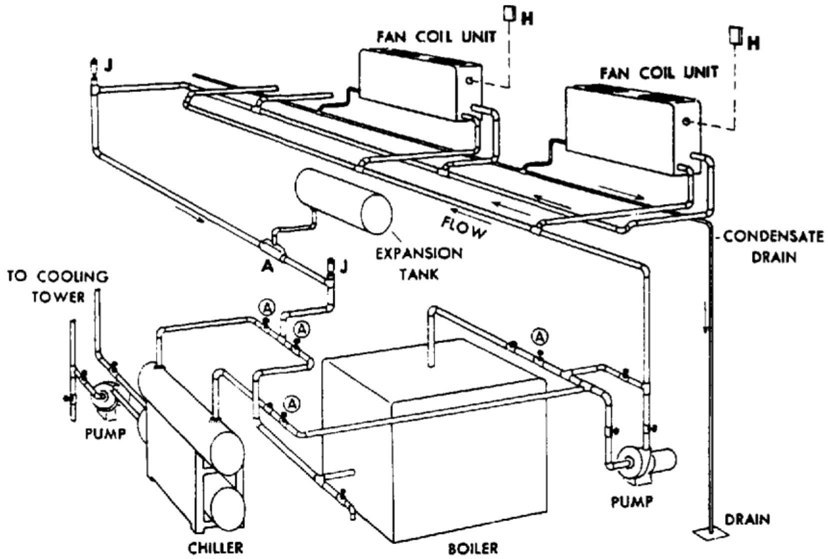

Figure 3. Hydronics Heating and Cooling System With Changeover Valves.
Illustration courtesy of Dunham-Bush, Inc.

The changeover valves at the locations indicated by a circled "A" permit the system to change from heating to cooling.

Air Control in Hydronic Systems

One problem that continues to crop up frequently in hydronic systems, unless handled properly, is the quantity of air permitted to circulate or clog a system. Air control systems that are properly designed and installed can eliminate major problems, reduce maintenance, cut cost of operation, and perform efficiently. Effective air control will also prolong the life of the system and reduce unnecessary noise. Depending on the type of system used, the admission of air to the system will vary.

Once-Through and Recirculating Systems

A once-through system passes water through the equipment only once, and then discharges it to a sewer. In a recirculating system, water is not discharged, but flows in a repeating circuit from the heat exchanger to the refrigeration equipment and back to the heat exchanger. Both of these types are further classified as open or closed systems.

Open and Closed Systems

An open system is one in which the water flows into a reservoir open to the atmosphere (i.e., cooling towers and air washers).

A closed system is one in which the flow of water is not exposed to the atmosphere at any point. These systems usually contain an expansion tank that is open to the atmosphere, but the water area exposed is insignificant.

Open systems are piping circuits pumped or gravity circulated. Closed systems are designed and installed as hermetically sealed systems. Some advantages of the closed or "sealed" system follow:

When a system is c

- With no add ... of oxygen and other corrosive age
- Closed syster ... mperature drops. Piping and op
- Closed system ... , faster temperature response, and

Whenever possible, cl ... en above. Sometimes design conditions requ ... e of a water tower when the heat load to b ... than 100 tons of refrigeration. The cooli ... sphere for these large cooling capacities

Although a system may ... up as an open system unless all compo ... Special consideration should be given to pump seals, ... installations.

Mechanical seals. Mechanical seals are required for all closed system circulating pumps. A specific kind of pump seal, known as the "packing gland" type, requires constant water leakage to provide seal lubrication. This means fresh water must be constantly added to the system or, theoretically, the system will eventually run dry.

Because fresh water contains air and other corrosive agents, system life and operation will be seriously affected. Also, foreign particles of sand and dirt that are often found in fresh water supplies will enter and accumulate within the system. Therefore, water-tight mechanical pump seals should always be used on closed hydronic systems.

Manual air vents. Manual air vents should be used where initial venting of high points in the system is necessary to fill the system with water. Automatic air vents, if allowed to operate