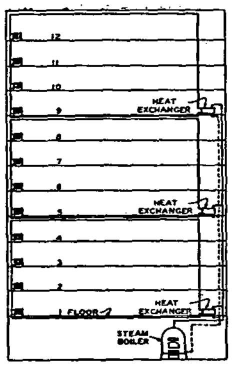
tures by room thermometers, and the determination of the temperature drop of water flowing through a heating unit or zone by means of surface contact thermometers or thermometers installed in the piping. When adjustment is made by means of water temperature drop, the capacity of the units after adjustment must equal the heat delivery actually required. Control is then accomplished by making the temperature drop through all units equal.



(Provision should be made for expansion in each closed circuit)

Fig. 20. . . . Vertical Zoning of Hot Water Heating System in a 12-Story Building

The procedure for making a permanent adjustment of heat distribution in a larger system should be as follows:

1. Select a time or day when conditions of heat gain are minimum; i.e., nighttime or an overcast day. Outdoor temperatures should be such as to require at least 50 percent of the system capacity to maintain the design indoor temperature.

2. Place the system in operation and make certain that all valves, adjusting fittings, and dampers are in the open position. Automatic control which might reduce the flow or capacity of any unit should be rendered inoperative. Doors and openings between rooms should be closed.

3. Prepare a form for recording data on temperatures in spaces or at the supply and return of heating elements or of zones.

4. After the system has reached equilibrium a complete record should be made of temperatures throughout the system.

5. An initial adjustment of flow regulating devices in the system should be made on the basis of the record of the original readings. A new set of temperature readings should be recorded after sufficient time has been allowed to establish a new equilibrium throughout the building.

6. Continue adjustments of flow control devices until a satisfactory condition is obtained.

7. When a satisfactory adjustment has been accomplished, it is advisable to *mark the position of each of the adjusting fittings or valves*. This facilitates return to proper control settings if the flow controls are disturbed by accidental or emergency changes at any time.

CARE AND MAINTENANCE OF SYSTEMS

A hot water heating system should last during the life of the building if it is designed, installed, and maintained properly. Maintenance instructions for individual elements of the system such as burners, motors, pumps, and accessories may be obtained from the manufacturers who supply this equipment. Two factors contribute in a most important way to the satisfactory operation and life of the hot water heating system: (1) the proper cleaning of the system when installed; and (2) a minimum change of water in the system, except as required by periodic maintenance of the boiler or draining of the expansion tank.

INITIAL CLEANING OF SYSTEM

Rules that should be followed for the initial cleaning of the system are:

1. All equipment and piping should be thoroughly cleaned of iron cuttings and other refuse during assembly and installation.

2. When installation is complete, the system should be filled with a solution of 1 lb of trisodium phosphate per 50 gal of water and should be operated for 24 hr at maximum temperature with all pumps operating. The system should then be drained and thoroughly flushed with water before refilling.

In order to minimize the addition of water to the heating system, the operation of air-vent valves, relief valves, and the tightness of the system generally should be subject to continuous inspection. Drips from automatic air-vent valves should discharge in places where leakage is readily detected. Continual operation of the pressure relief valve should be a signal for the inspection, repair, or replacement of the relief valve, or a check on the operation of the expansion tank or the automatic water feeder, if one is provided.

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CHAPTER 29

HIGH-TEMPERATURE WATER SYSTEMS

Features; Basic System; Design Considerations: Boilers, Boiler Piping and Controls, Direct-Contact Heaters and Auxiliary Heat Exchangers, Boiler Feed Pumps, Circulating Pumps; Distribution Piping Design: District Distribution, Pipe, Valves and Fittings, Thermometers and Pressure Gages; Space Heating Equipment; Temperature Control; Water Treatment; Storage

HIGH-TEMPERATURE water systems discussed in this chapter are those operating with supply water at temperatures exceeding 250 F. Operating temperatures range from 250 to 450 F, with pressures from 55 to 450 psig. High-temperature water systems used in the United States are predominantly closed-type systems.

This chapter is intended to give a broad general idea of principles and practices that apply to high-temperature systems and distinguish these systems from the systems operating below 250 F.

FEATURES OF SYSTEMS

The following are among the outstanding features of high temperature as compared to low temperature systems:

1. It is common practice to use greater temperature drops.

2. Supply and return piping may be given the same pitch or grade, or may be run level. Grading is desirable but a definite minimum pitch is not required.

3. Piping may slope up or down or run at a variety of elevations to suit the terrain and the architectural and structural requirements without provision for drainage at each low point except for emptying sections of piping for shutdown. This feature may reduce the excavations required.

4. The pressure in any part of the system must always be above the pressure corresponding to the temperature at saturation in the system in order to prevent flashing of the water into steam.

5. Processes requiring different temperatures of water may be served at their required temperatures by use of heat exchangers, by regulating the flow to certain processes, by placing some processes in series with others, etc.

6. Heat may be stored in the mains and boiler by build-up of temperature in the return main during periods of light load.

THE BASIC SYSTEM

High-temperature water systems are basically similar to the conventional forced hot water heating systems since they require boilers or direct contact heaters for heating the water, expansion or pressurizing tanks, circulating pumps, distribution piping, and heat transfer or emission equipment, as shown in Fig. 1. The principal differences from the low temperature system are the higher pressure used, the consequently heavier equipment, and the manner in which pressure is maintained on the water. When cushioned by steam in the boiler, the system in effect is a hot water system using a boiler producing steam to heat the water. The supply piping draws water from the boiler below its water level so that water flow may occur even though steam is kept above the surface of the water.

Water is circulated in a closed circuit from the central station to areas where heat is required and back to the boiler.

The size of installation, the extent of the load, and the operating temperature will govern central boiler-plant design and construction. Some determining considerations are:

1. Type of load: heating, process, or both.

2. Distance from heating plant to space or process requiring heat.

3. Terrain of land on which buildings are located.

4. Zoning requirements based on occupancy and load distribution.

5. Quantity of steam used for power equipment, if required.

Variations in elevation may make it desirable to locate the boiler house on the highest ground in order to obtain maximum static pressure head on the system. Boiler auxiliaries such as boiler feed pumps, pressure tanks, economizers, and system circulating pumps are usually located in the boiler house, as indicated in Fig. 2.

DESIGN CONSIDERATIONS

Factors to be considered in selecting the type of boiler are (1) the maximum operating pressure of the system, (2) the water temperature requirements during a 24-hr operating period, (3) the size of the load, and (4) temperature drop across the boiler. Process loads may require water at a given minimum supply temperature continuously, while space heating and other loads may permit a lower water temperature at night or an off period during each 24-hour operating period.

Theoretically, water temperatures up to about 350 F may be provided using boilers and piping suitable for 125 psig, but practically, maximum water temperatures will be limited by the system design and elevation characteristics to values between 300 F to 325 F. Most systems are being designed with the system circulating pump in the supply line and with a steam drum for pressurization, expansion, and tem-

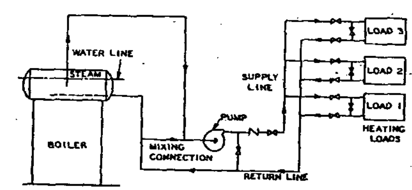

Fig. 1 . . . . Elements of a High-Temperature Water System