

ing the coil were circulating slowly. Ratings of instantaneous water heating coils will therefore vary greatly, depending upon the assumptions made regarding the conditions of operation. The values of the coefficient of heat transmission for instantaneous heaters, shown in Table 17, are conservative.

For a coil in which heat is transferred from steam to water, the value of $U = 300 \sqrt{v}$ may safely be used (v = velocity of water in feet per second).

The rate of heat transfer, between steam or water as the carrier, and the domestic water, is influenced by the rate of movement of both the carrier and the water which receives the heat. For this reason, where the transfer occurs from heating system water to domestic water, it is good practice to install a circulating pump to insure rapid movement of the boiler water.

In view of the high condensation rates obtained when steam is used with gravity circulation from the boiler, particularly when there is a sudden demand followed by an inflow of cold water, the bottom of a steam heat transfer element always should be at least 30 in. above the boiler water line, and the steam and condensate return pipes should be of liberal size. Otherwise, water hammer and reduced capacity may result, due to imperfect drainage of condensate.

When connecting a transfer-type hot water heater below the waterline of a cast-iron steam boiler having vertical sections, there should be a separate tapping for water circulation into every section of the boiler, as shown in Fig. 12, unless the boiler has large top nipple ports providing inter-sectional circulation. If the top nipples are entirely within the boiler steam space, no internal circulation occurs between sections. Steaming may then occur in the boiler sections not connected to the heater and, further, the unconnected sections will not deliver any heat to the water heater.

HOT WATER SUPPLY PIPING

It is common practice to provide circulating piping in all hot water supply systems in which it is desirable to have hot water available continuously at the fixtures. In average-sized and small residences and systems, in which the piping from the heater to the fixtures is short, return circulating piping is generally omitted in order to reduce installation cost, and to reduce heat loss from the piping, particularly during periods of no water demand.

The hot water supply may be distributed by either an up-

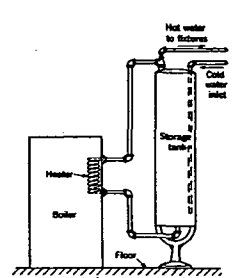


Fig. 13 Indirect Water Heater Placed in Boiler

feed or down-feed piping system. Three common methods of arranging the circulating lines are shown in Fig. 14. Although the diagrams apply to multi-story buildings, the arrangements (a) and (b) are sometimes used in residential designs.

A check valve should be provided in the main return to prevent temporary reversal of flow. Proper air venting of a circulating system is extremely important, particularly if gravity circulation is employed. In Fig. 14 (a) and (b), this is accomplished by connecting the circulating line below the top fixture supply. With this arrangement, air is eliminated from the system each time the top fixture is opened.

Where an overhead supply main is located above the highest fixture as in Fig. 14 (c), an automatic float-type air vent is installed at the highest point of the system, or a fixture branch is connected to the top of the main where air venting is desired, and then dropped to the fixture outlet.

It is sometimes necessary to make an allowance for pressure drop through the heater when sizing hot water lines, particularly where instantaneous hot water heaters are used and the available pressure is low.

The principles involved in the sizing of the hot water supply pipes are the same as those for the sizing of cold water supply lines. For small and medium sized installations a 1/2-in. hot water return will be ample. For larger installations, the size of the hot water return may be computed from considerations of the heat losses in the hot water piping. A throttling valve should be placed in the hot water return pipe so that the rate of circulation may be adjusted.

Where the hot water piping system is exceedingly long, a water circulator is frequently installed. It is controlled by an immersion thermostat (in the return line) set to start and stop the pump over approximately a 20 F deg temperature range. In calculating the pump capacity, the product of (1) the pounds of water circulated and (2) the temperature difference (usually 20 deg) between the flow and return, must be equivalent to the Btu heat loss from the piping at the average temperature of the water. Insulation reduces the heat loss and pump capacity required. A simplified method of sizing hot water circulating pumps is to allow 1 gpm for every 20 fixtures in the system, or to allow 1/2 gpm for each 1/4 or 1 in. riser, 1 gpm for each 1 1/4 or 1 1/2-in. riser and 2 gpm for each riser 2-in. or larger. The friction head against which the pump must operate may be calculated from the tables and charts in Chapter 8, Hot Water Heating Systems.

Since service water is corrosive due to the high oxygen

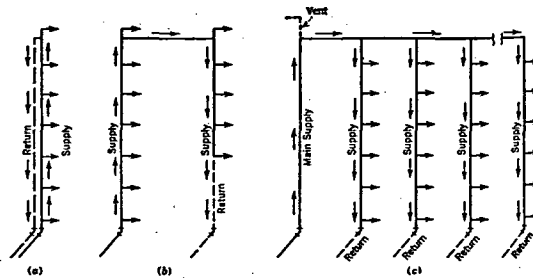


Fig. 14 Methods of Arranging Hot Water Circulation Lines

content and high temperature, circulating pumps should be made of bronze.

Where automatic dishwashers are installed in commercial kitchens, adequate water piping is essential to insure recommended pressures and flow rates at the sanitizing rinse nozzles. To reduce operating difficulties, the installation of piping for automatic dishwashers should be made in accordance with the following recommendations:

1. The supply line for 180 F water from the water heater to the dishwasher should not be less than 1/2 in. ID pipe size.
2. There should be no auxiliary feed lines connected to the 180 F supply line to the dishwasher.
3. A water pressure gauge and thermometer should be installed in the 180 F water line adjacent to the dishwasher.
4. The cold water feed line to the water heater should not be less than 1 in. ID pipe size. For engineering data on proper pipe sizing, refer to the American Standard National Plumbing Code.
5. A return line should be installed when the water heater is more than 5 ft from the dishwasher. Gravity return is permissible if the heater is installed at a lower level than the dishwasher and the length of return flow is not over 60 ft.
- When gravity circulation is used, the piping should be installed so that the supply and return lines are not trapped.
6. Forced circulation by a pump should be used if the water heater is installed on the same level as the dishwasher, if the length of return piping is more than 60 ft, or if the water lines are trapped.
7. If a circulating pump is used, it is generally installed in the return line. It may be controlled by: (a) the dishwasher wash switch, (b) a manual switch located near the dishwasher, (c) an immersion thermostat built as an integral part of the pump, or (d) an immersion thermostat located in the return line near the pump.
8. A pressure-reducing valve should be installed in the supply line adjacent to the dishwasher, but external to the recirculating loop.
9. An approved (ASME) temperature and pressure relief valve, or an approved energy cut-off, should be installed in the heater opening provided by the manufacturer or as close as possible to the heater. Local code requirements should be followed.
10. A check-valve should be installed in the return circulating line near the heater.
11. If a check valve type water meter is installed in the cold water line ahead of the heater, it is necessary to install an operating pressure relief valve between the water meter and the heater. The operating relief valve should be set at a pressure lower than the setting of the safety valve mounted on the heater (or in the hot water line leaving the heater).

Water Pressure

Proper flow pressure must be maintained to achieve efficient dishwashing operation. The standards of The National Sanitation Foundation for dishwasher water flow pressures are 15 psig minimum, 25 psig maximum, and 20 psig for ideal operation.

Flow pressure should not be confused with the static water pressure. Static pressure is the line pressure measured when no water is flowing. Flow pressure is the line pressure measured when water is flowing through the rinse arms of the dishwasher. Low flow pressure can be due to undersized water piping, stoppage in old water piping, or excess pressure drop through water heaters.

Low water pressure causes an inadequate rinse, resulting in poor drying and sanitizing of the dishes. If flow pressure in the supply line to the dishwasher is below 15 psig, a booster pump should be installed to provide supply water at 20 psig.

A flow pressure in excess of 25 psig will cause atomization of the 180 F rinse water, resulting in an excessive temperature drop. Between the rinse nozzle and the dish rack area the temperature drop can be as much as 15 deg.

A pressure regulator, approved for 180 F operation, should be installed in the rinse water line adjacent to the dishwasher and external to the return circulating loop. The regulator should be set to maintain a pressure of 20 psig.

CONTROL OF SERVICE WATER TEMPERATURE

Coal-fired boilers are usually controlled by an immersion thermostat (located in the heated water) which opens or closes draft dampers at the boiler to adjust the rate of fuel combustion. With oil- or gas-fired boilers, the immersion thermostat controls the oil burner or the automatic gas valve. The gas pilot flame usually burns continuously. With electric heaters, the immersion thermostat operates a switch on the source of energy.

When steam or hot water is the medium for heating the water in the tank, an immersion thermostat is used to control a valve in the steam or hot water supply line. In small residence installations, using water as the carrier, a combined immersion thermostat and butterfly valve in one simple fitting may be installed in the transmitting circuit to prevent overheating of the service water.

In residences heated by pump-circulated hot water, the house temperature is controlled by operating the circulating pump intermittently, while domestic hot water is warmed by transfer from the house boiler, independent of the pump operation. The domestic water is heated from the heating boiler the year-round. Under such an arrangement, to prevent overheating the house by thermal circulation when the pump is not running, it is usual to insert a weighted check valve in the house heating main so that no circulation to the house heating system can occur unless the pump operates. In summer the fire may be controlled to maintain a boiler water temperature lower than when heating, and generally about 20 F warmer than that desired in the domestic hot water system.

The immersion thermostat in a hot water storage tank should be located no higher than the center of the tank, and possibly should be even closer to the bottom, since water in a tank stratifies proportionally to the temperature. When hot water is removed, the cold water entering to replace it quickly reduces the temperature in the lower parts of the tank.

For general information on automatic control see Chapter 13 of the 1961 GUIDE AND DATA BOOK.

SAFETY DEVICES FOR HOT WATER SUPPLY SYSTEMS

There are still numerous plumbing codes which do not have regulations for the prevention of hot water storage tank explosions.

An ordinary storage tank is under certain water pressure, depending on the static pressure in the system. When the water in the tank is heated by circulation through an external heater, or by heating units in the tank, it gradually expands. For instance, if the entire contents of a 30-gal storage tank are heated from 70 F to 160 F, there will be an increase in volume of about one-half gallon. If the tank is connected to a supply line without any intervening check valve, the increase in volume causes part of the water to be pushed back into the supply line. If the hot water reaches the water meter, it may ruin the composition discs.

If back-flow cannot occur, as for example, due to the use of a check valve or a pressure-reduction valve in the line, or because of temporary shut-off of the cold water line, the pressure in the tank rises as heating continues. Such a pres-