

Fig. 19 .... Connection of Horizontal Unit Heater to Hot Water System

function as intended. Basic piping principles for steam systems are discussed in Chapter 8, 1964 Guide And Data Book.

Rapid condensation of steam, especially during heating-up periods, is characteristic of steam unit heaters. The return piping must be planned to keep the heating coil free of condensate during periods of maximum heat output, and the steam piping must be ample to carry a full supply of steam to the unit to take the place of that condensed. Adequate sizes of piping are especially important where a unit heater fan is operated under on-off control, because the condensate rate fluctuates rapidly.

Recommended piping connections for unit heaters are shown in Figs. 15 to 19.

In steam systems, the branch from the supply main to the heater should pitch toward the main and be connected to its top, to prevent condensate in the main from draining through the heater, where it might reduce capacity and cause noise.

The return piping from steam unit heaters should provide a minimum drop of 10 in. below the heater, so that the head of water required to overcome resistances of check valves, traps, and strainers will not cause condensate to remain in the heater.

Dirt pockets at the outlet of unit heaters are essential, and strainers with $\frac{1}{16}$ in. perforations to prevent rapid plugging are recommended as an additional means of retaining dirt and scale which might affect operation of check valves and traps. Strainers should always be installed in the steam supply line, if the heater is equipped with the steam-distributing type of coils or is valve-controlled.

An adequate air vent is required for low-pressure closed-gravity systems. The vertical pipe connection to the air vent should be at least $\frac{3}{4}$ in. IPS, to permit separation of the water from the air passing to the vent.

In vacuum systems, if thermostatic instead of float-and-thermostatic traps are used, a cooling leg must be provided ahead of the trap.

In high-pressure systems, it is customary to vent the air through a petcock which is left slightly open at all times. Where possible, it is advisable to install pressure reducing valves to permit operation of the heaters at low pressure. Traps used must be suitable for the operating pressure encountered.

When piping is connected to hot water unit heaters, it should be pitched to permit the escape of air to the high point in the piping, where it can be vented to the atmosphere. An air vent at the heater is used to facilitate air removal or to vent the top of the heater. Provision should be made for complete drainage of the system, including nipple and cap drains or drain cocks where units are located below mains.

Maintenance

Regular inspection, based upon a schedule determined by the amount of dirt in the atmosphere, will insure maximum economy in operation and maintenance of heating capacity.

Heating elements should be cleaned when necessary by brushing or blowing with high-pressure air, or by using a steam spray. Removal of the heating element and washing with a mild alkali solution, followed by thorough rinsing with water, may be necessary in certain installations.

Dirty fan blades will cause capacity losses and may cause unbalance and vibration, with consequent noise and damage to bearings. Hence, fan blades should be cleaned when necessary. Vibration or noise may also be caused by improper fan position or loose set screws.

There is considerable difference in the attention required by the various types of motors used with unit heaters. This is particularly true of lubrication, the instructions for which must be carefully followed for trouble-free operation. Excessive lubrication may cause lubricant to reach and damage the motor. An improper lubricant may cause failure of bearings. Instructions for care of the motor on any unit heater should therefore be obtained from the manufacturer and should be kept at the unit.

Fan bearings and drives must be given the lubrication and other attention specified by the manufacturer. If the unit is direct-connected, the couplings should be inspected periodically for wear and alignment. V-belt drives should have all belts replaced with a matched set if one belt shows wear.

Periodical inspections of traps, check and air valves, and the replacement of worn parts are important maintenance items. Strainers should be cleaned regularly.

When filters are incorporated in the unit, they must be cleaned or replaced when dirty.

For prevention of corrosion in unit heaters, see Chapter 15, Corrosion and Deposits, in this edition and also Bulletin 12, *The Care and Maintenance of Steam and Hot Water Unit Heaters*, published by the Air Moving and Conditioning Association, Inc.

REFERENCES

[1] *ASHVE Standard Code for Testing and Rating Steam Unit Ventilators* (ASHVE Transactions, Vol. 38, 1932, p. 25).

[2] G. L. Larson, D. W. Nelson, and R. W. Kubasta: ASHVE Research Report No. 936—Investigation of air outlets in class room ventilation (ASHVE Transactions, Vol. 38, 1932, p. 463). F. C. Houghten, Carl Gutberlet, and M. F. Lichtenfels: ASHVE Research Report No. 1017—Air supply to classrooms in relation to vent flue openings (ASHVE Transactions, Vol. 41, 1935, p. 279).

[3] *Standard Code for Testing and Rating Steam Unit Heaters* (Air Moving and Conditioning Association, *AMCA Bulletin* No. 20, 1950).

[4] *Standard Code for Testing and Rating Hot Water Unit Heaters* (Adopted jointly by The American Society of Heating and Ventilating Engineers and Industrial Unit Heater Association, *IUHA Bulletin* No. 11, April 1953, 2nd ed).

[5] G. L. Larson, D. W. Nelson, and O. C. Cromer: ASHVE Research Report No. 958—*Temperature gradient observations* in a large heated space (ASHVE Transactions, Vol. 39, 1933, p. 243). G. L. Larson, D. W. Nelson, and John James: ASHVE Research Report No. 1011—Tests of three heating systems in an industrial type of building (ASHVE Transactions, Vol. 41, 1935, p. 185).

[6] *Piping, Trapping and Venting Steam and Hot Water Unit Heaters (Air Moving and Conditioning Association, Inc., Bulletin* No. 15).

CHAPTER 55

RADIATORS, CONVECTORS, BASEBOARD AND FINNED-TUBE UNITS

Definitions, Heat Emission, Radiators, Convectors, Baseboard, Finned-Tube, Ratings, Corrections for Non-Standard Conditions, Enclosed Radiators

RADIATORS, convectors, baseboard, and finned-tube units are types of heat-distributing units commonly used in steam and low temperature water heating systems. They supply heat through a combination of radiation and convection, and their function is to maintain the desired air temperature in the space. In general, these types of heat-distributing units should be placed at the points of greatest heat loss of the space, so as to offset or counteract these losses. For example, such units are commonly located under windows, along exposed walls, and at door openings.

The term *radiator* is generally confined to sectional cast-iron radiation of column, large tube, or small tube type.

The term *convector* refers to a heat-distributing unit that operates with gravity circulated air, has a heating element with a large amount of secondary surface, and is surrounded on all sides by an enclosure having an air inlet opening below, and an air outlet opening above, the heating element.

The terms *baseboard* or *baseboard radiation* refer to heat-distributing units designed for installation along the bottom of walls, in place of the conventional baseboard. They may be made of cast-iron, with a substantial portion of the front face directly exposed to the room, or with a finned-tube element in a sheet metal enclosure. They operate with gravity-circulated room air.

The term *finned tube* refers to heat-distributing units fabricated from metallic tubing with metallic fins bonded to the tube. They operate with gravity-circulated room air, and may be installed without an enclosure, with an open type grille, a cover, or an enclosure having top, front, or inclined outlets.

HEAT EMISSION

These types of heat-distributing units emit heat by a combination of radiation to the space and convection to the air within the space. These heat transfer processes and the factors which influence them are discussed in detail in Chapter 4. In general, those units which have a large portion of their heated surface exposed to the space, i.e., radiators and cast-iron baseboard, emit a larger portion of heat by radiation than do units having completely or partially concealed heating surface, i.e., convectors, finned tube, and finned tube type baseboard.

The output ratings of these types of heat-distributing units are expressed in units of Btu per hour (Btuh), 1000 Btu per hour (MBh), or in square feet equivalent direct radiation (EDR) (e.g., 240 Btuh = 1 sq ft EDR with 1 psig steam). Ratings in EDR are largely being abandoned by many manufacturers in the industry.

The general responsibility for this chapter is assigned to TC 3.1, Hot Water and Steam Heating.

RADIATORS

Column and *large-tube radiators* are no longer manufactured, but, since many of these units are still in use, Tables 1 and 2 are included to provide principal dimensions and average ratings.

The *small-tube* type radiators, with a length of only $1\frac{1}{2}$ in. per section, occupy less space than the older column and large-tube units, and are particularly suited to installation in recesses.

After a study of the demand for various sizes of radiators, the Institute of Boiler and Radiator Manufacturers, in cooperation with the Division of Simplified Practice of the National Bureau of Standards, established the *Simplified Practice Recommendation R174-47, Cast Iron Radiators*, for small-tube radiators. Table 3 shows the dimensions and ratings of the units now being manufactured under R174-47.

Wall radiators are well adapted to use in factory buildings, storage areas, etc. Tests have shown that the heat emitted from a wall type radiator may be reduced 5 to 15 percent, if the radiator is located at the ceiling with the tubes horizontal. Such ceiling installations are not recommended because the resulting temperature gradients between floor and ceiling are excessive and make it difficult to heat the living zone satisfactorily. Dimensions and output ratings of wall type radiators in normal wall installation are given in Table 4.

PIPE COILS

Pipe coils were once a popular type of heat-distributing unit in factory buildings, but they have now largely been replaced by finned-tube radiation. The heat emission of such pipe coils is shown in Table 5, for purposes of estimating replacement requirements and boiler loads.

CONVECTORS

Convectors are made in a wide variety of depths, sizes, lengths, and enclosure or cabinet types. The basic sizes and types are listed in *Simplified Practice Recommendation* 238-50, *Convectors*. The heating elements are available in fabricated ferrous and non-ferrous metals. The air enters the enclosure below the heating element, is heated in passing through the element, and leaves the enclosure through the outlet grille located above the heating element. Factory-assembled units comprised of a heating element and enclosure are widely used. These may be free standing, wall hung, or recessed (Fig. 1); and may have outlet grilles and arched inlets or inlet grilles, as desired.

In cases where cabinets or enclosures are to be used, but are not furnished by the manufacturer, it is important that the proportions of the cabinets or enclosures and the grilles