etc., need careful consideration. The larger the system, involving heat distribution circuits of three, four, five miles or more, the greater will be the frictional head on the pumps, so every care should be taken to reduce the head loss in the boiler to a minimum and thus reduce the pump horsepower. Frictional loss through a boiler operating with entrained steam and air in the tubes and headers, can be a serious factor.

Balancing is another problem which can be made simple when the system is well designed. During the spring and autumn months and in mild weather at any time, the heat load will be low and only one boiler will be required. To put a boiler on the line or take one off is simplified if all boiler supply lines are connected into a common expansion drum. Boilers are then controlled from the pressure developed in the drum and the high temperature water supply taken through a dip pipe below the water level.

Since the heat storage in the system is very high (Table 9 illustrates this in Btu per cubic foot) advantage of this high temperature water characteristic can be taken when considering the number and output of the boilers. The output of the central boiler plant can be greatly reduced and the initial cost of the system lowered accordingly if the thermal storage of the system is taken into account.

Storage

High temperature water systems offer the opportunity of storing heat to even out the peak loads and low loads within the 24-hour cycles. Storage is usually accomplished by means of by-passing water from the flow to the return mains and thereby storing heat in the return main for future use, or by accumulators. Systems which experience normal peaks can obtain as much as 15 percent added capacity through this heat storage. Where peaks are more severe, this storage or thermal flywheel will allow even greater savings.

Distribution

The conventional conduit or tunnel distribution systems are employed with similar techniques used for installation except that grading of the piping is not important. The mains may be run at different elevations at will, although the high points should be vented by the use of air collectors and the low points should be drained.

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CHAPTER 23

RADIATORS AND CONVECTORS

Heat Emission of Radiators and Convectors, Radiators, Convectors, Ratings of Radiators and Convectors, Effect of Operating Conditions, Heating Effect, Heating Radiators and Convectors, Enclosed Radiators

RADIATORS and convectors are heat emitting units used in steam and hot water heating systems for supplying heat by radiation and convection to a room. The function of any radiator or similar device is the maintenance of occupancy comfort through the control of the mean radiant and air temperatures in the area. Since heat losses through the various parts of the structure constantly tend to lower these temperatures below the comfort point, the radiator or convector should be so placed and regulated that its output will replace the losses when and where they occur. If 80 percent of the room heat loss occurs through a cold wall or window area, then 80 percent of the input should be introduced in or directed toward that area.

The term *radiator* refers to a unit which emits a large part of its heat by radiation and includes cast-iron radiators, baseboard radiation and pipe coils. Cast-iron radiator types may be column, large-tube, small-tube or wall. Baseboard radiators may be of the radiant cast-iron type, radiant-convector cast-iron type, or finned-tube type. The last type, however, is actually a convector.

The term *convector* refers to a unit which emits the greater portion of its heat by convection. It includes such units as conventional convectors in which a heat emitting element of either cast-iron or of the finned-tube type is enclosed in a cabinet, but may also be of the unenclosed finned-tube type.

HEAT EMISSION OF RADIATORS AND CONVECTORS

Most heating units emit heat by *radiation* and *convection*. An exposed *radiator* emits roughly half of its heat by radiation, the amount depending upon the size and number of sections. In general, a thin radiator, such as a wall radiator, emits a larger proportion of its heat by radiation than does a thick radiator. When a radiator is enclosed or shielded, the proportion of heat emitted by radiation is reduced. The balance of the emission occurs by conduction to the air in contact with the heating surface, and this heated air rises by circulation due to convection, and transmits this warm air to the space which is to be heated.

Convectors transfer the smaller proportion of their heat to the room by radiation. Since most of their heat is transferred by convection, the heat emission is dependent upon the vertical distance between the heating element and the outlet grille at the top of the convector cabinet.

The output of a radiator or convector can be measured only by the heat it emits and is generally expressed in units of: Btu per hr; *Mbh* (1000 Btu per hr); or in equivalent direct radiation (*e.g.*, 240 Btu per hr for steam).