

proper because the minimum outside temperature for which the heating system is designed and for which the heat losses are calculated, occurs only a few times in any one year and perhaps never in some years. Consequently, it is very seldom and in some years never necessary to heat the water to the assumed maximum temperature.

If 220 deg. is selected as the maximum temperature, it is necessary to provide sufficient pressure on the water in all radiators and in the entire pipe system so that the water will not boil at that temperature. This can be accomplished easily in all closed systems and also in all open systems. In the latter case, it is only necessary to place the expansion tank at a sufficient altitude above the highest point in the heating system to secure the desired pressure. For example: If the expansion

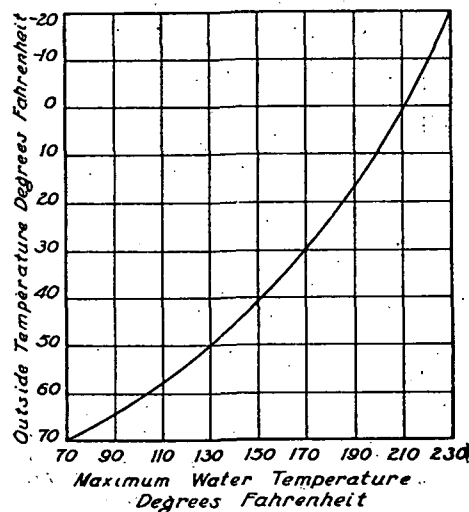


FIG. 3. VARIATION, WITH THE OUTSIDE TEMPERATURE, OF THE REQUIRED MAXIMUM WATER TEMPERATURE IN THE HEATING SYSTEM

tank is located 10 ft. above the highest point in the system and if the expansion tank riser is filled with 200 deg. water when the flow risers carry 220 deg. water, the pressure at the highest point of the heating system will be about 4.2 lb. per square inch. The corresponding boiling point is about 226 deg. and there would be no danger of boiling so long as the temperature of the water leaving the heater is not above 220 deg.

In such cases the expansion tank riser should be connected to the return main. Precautions must always be taken to prevent freezing of the water in the expansion tank or in the expansion tank riser.

Having assumed the maximum temperature of the water for the minimum outside temperature, the required water temperature for any other outside temperatures may be calculated and represented by a curve similar to that of Fig. 3, which may be used as a guide by the operating engineer.

Such a curve will, however, not show the correct water temperatures for all times, as heat losses of buildings depend upon the direction and velocity of the wind. The values shown by the curve must, therefore, be modified from time to time by the operating engineer according to the character of the wind prevailing at the time.

Temperature Drop through the Radiator

For any given radiator the drop in the temperature of the water as it flows through the radiator is determined by the quantity of water flowing through the radiator in a given time. For example: If a radiator is to dissipate 10,000 B.t.u. per hour with a temperature drop of 10 deg., it is necessary that 1,000 lb. of water flow through the radiator per hour. If, on the other hand, the temperature drop is to be 20 deg., only 500 lb. of water must flow through the radiator per hour. If, in both cases, the same size pipe is used, the velocity of the water must be twice as high in the former case as in the latter, and since the friction of water in pipes varies almost as the square of the velocity, it follows that the friction head is almost four times as great in the former case as in the latter. If, in both cases, the friction head must have a fixed value—the same as that of the available pressure head—it is evident that the temperature drop through the radiator decreases as the pipe sizes are increased. It has been shown that the required size of the radiator decreases as the temperature drop through the radiator decreases.

Reducing the temperature drop through the radiator raises the average temperature of the water and therefore decreases the sizes of the radiators but increases the sizes of the piping; in other words, it decreases the cost of the radiators but increases the cost of the piping. There is, consequently, an optimum temperature drop through the radiators for every installation, which carries with it the lowest cost of installation. This optimum temperature drop can be determined by a few trial calculations. As a rule, such calculations are never made; the temperature drop is selected arbitrarily.

A temperature drop of from 15 to 30 deg. is common and generally quite satisfactory.

Arrangement of Piping

Having determined the location of the heater and the location of the several radiators, there are a number of ways in which the piping can be arranged to connect the heater and the radiators to secure a system that operates satisfactorily, provided the radiators and the pipes of the system are of correct size so that, in every case, the pressure head for every radiator is exactly equal to the friction head in the circuit of that radiator, when the system is operating at a uniform rate and when each radiator is producing its correct quantity of heat.

Attempts have been made to assign distinctive names to the several methods or types of piping for hot water heating systems. The result is not entirely satisfactory because it is possible to have many variations of each typical method or system of piping. The following definitions will serve to describe the more common general types of piping:

1. A *one-pipe* system is one in which the water flows through more than one radiator before it returns to the heater and, consequently, the radiators farther from the heater are supplied with cooler water than those nearer the heater and in the same circuit.