

9 • What is the approximate relation for heat losses?

Heat losses from the body when in a sedentary position are approximately as follows: radiation 49 per cent, convection 23 per cent, evaporation 15 per cent, respiration 11 per cent, and miscellaneous 2 per cent. Actually, it depends upon age, environment and other conditions.

10 • Differentiate between radiant and convection heating.

The primary function of radiant heating is to regulate the loss of heat from the body without unduly heating the air; while in convection heating it is generally the function of the heating medium to transfer the heat to the air and thence to the occupant of the room.

11 • What generally is the air temperature necessary to give equal comfort effect for sedentary conditions?

With radiant heating, 64 to 66 F. With convection heating, 70 to 72 F.

12 • Why is there a saving in fuel consumption with radiant heating?

A saving is effected because the differential between inside and outside temperature is much less for radiant heating. Less ventilating air is necessary and this can be supplied at a much lower temperature.

13 • What is the mean normal surface temperature of the human body as determined for the United States?

83 F.

14 • Describe how to calculate the required amount of radiant heating surface.

- Obtain the mean heat emission in Btu per square foot per hour for room surfaces X , using values in Table 1, and surface temperatures as shown in second column of Table 2.
- Deduct X from 142 (142 being the emission per square foot given off by the human body at 83 F surface temperature) = Y in Btu per square foot per hour.
- From $(142 - X)$ deduct 11.1 (11.1 being the average radiation which the human body should lose per square foot for comfort conditions) = $(142 - X - 11.1) = Z$.
- Multiply total interior surface of room by Z and divide by the emission per square foot from radiant heater, giving the surface S of radiant heater in square feet.

15 • Give a simple formula to calculate radiant heating surface required, and explain.

$$S = \frac{(142 - X - 11.1) A}{B}$$

where

- S = surface of radiant heater, square feet.
 142 = Heat emission, Btu per square foot per hour which the human body would give off at 83 F, with surroundings at absolute zero.
 X = mean heat emission, Btu per square foot per hour from surfaces of room.
 11.1 = heat emission, Btu per square foot per hour from human body.
 A = total surface, square feet of walls, ceilings, windows, etc., in room.
 B = heat emission per square foot from radiant heater surface.

16 • What natural evidence have we that air temperature alone is no criterion of comfort and that radiant heat affects the body more quickly?

When standing in the sunshine on a cool spring day, a person feels perfectly comfortable, but when a cloud passes over the sun, he instantly feels much cooler as the shadow reaches him. A shielded thermometer recording the temperature of the air shows no reduction in air temperature in so short a period, so that the person actually feels a sensation of cold which an ordinary thermometer cannot register. This shows that light and heat rays are shut off simultaneously and travel at the same speed; it also proves that radiant rays affect the comfort of the body quicker than air temperature does.

Chapter 39

ELECTRICAL HEATING

Resistors, Heating Elements, Electric Heaters, Unit Heaters, Central Fan Heating, Electric Steam Heating, Electric Hot Water Heating, Electric Hot Water Heating for Domestic Supply, Industrial Heating, Cooling and Reverse Cycle Heating by Electric Refrigeration, Auxiliary Electric Heating, Control, Calculating Capacities, Power Problems, Insulation, Electric Heating Data

ELECTRIC heating is steadily assuming a more important place in heating, ventilating and air conditioning installations, accelerated in many territories by the load building efforts of the utilities which usually include reduced rates to encourage such installations. Electrical heating has a logical place in the heating industry because of its features of flexibility, cleanliness, safety, convenience and ease of control. Electrical heating practice has many basic principles in common with fuel heating, but there are also important differences. When heat units are delivered to each room by wire, no combustion process is necessary, either at a central plant or at the individual room units. The maximum output of an electric heater is a fixed constant, unaffected by the temperature of the surrounding air and it follows that the maximum total load on an electrical heating system is the total wattage of connected electric heaters, regardless of weather conditions. The real obstacle to the more general adoption of electric heating for buildings is the cost of the electricity itself. Because the heat units produced electrically are more costly, their conservation is of more relative economic importance than with fuel heating, so that sponsors of electric heating give greater attention to temperature-insulated building construction.

All heat is a form of energy. Fuels hold stored chemical energy which is released into heat by combustion. Electrical power is a form of energy which can be released into heat by passing it through a resisting material. Both fuel and electric heating have two divisions: *first*, the conversion of energy into heat; *second*, the distribution and practical use of the heat after it is produced.

In converting the chemical energy of fuels into heat by combustion, there is necessarily a considerable variation in thermal efficiency. This is not true, however, when converting electric power into heat, because 100 per cent of the energy applied in the resistor is always transformed into heat. In electric heating practice the engineer need not be concerned about efficiencies of heat production, but rather about efficiencies of heat utilization. It is the engineer's problem to distribute the electrically produced heat units in such manner as to obtain conditions of maximum comfort with the minimum consumption of electricity.