CHAPTER 15

INFRARED RADIANT HEATING

RADIANT principles discussed in this chapter apply to equipment with radiant source temperatures ranging from below room temperature to 5000°F. Radiant source temperatures are categorized into four groups as follows:

- Low temperature
- Low intensity
- Medium intensity
- High intensity

Low-temperature or panel heating and cooling systems have source temperatures up to 300ºF. Typical low-temperature sources are the ceiling and/or floor of the conditioned space. The source of energy for this application can be electrical resistance wire or film element, hot water, or warm air. Low-temperature radiant heating is used in residential applications and in office, commercial, or industrial buildings. These systems are often applied in conjunction with variable air volume (VAV)systems. Chapter 6 has further information on low-temperature (panel heating and cooling) systems.

Low-intensity source temperatures range from 300 to 1200ºF. A typical low-intensity heater is mounted on the ceiling. It may be constructed of a 4 in. steel tube 20 to 30 ft long. A gas burner inserted into the end of the tube raises the tube temperature, and, because most units are equipped with a reflector, the radiant energy emitted is directed down to the conditioned space.

Medium-intensity source temperatures range from 1200 to 1800ºF. Typical sources include porous matrix, gas-fired infrared or metal sheathed, electric units.

High-intensity radiant source temperatures range from 1800 to 5000ºF. A typical high-intensity unit is an electrical reflector lamp with resistor temperatures of 4050ºF.

Low-, medium-, and high-intensity infrared heaters are frequently applied in aircraft hangars, factories, warehouses, foundries, greenhouses, and gymnasiums. They are applied to such open areasas loading docks, racetrack stands, under marquees, outdoor restaurants, and around swimming pools. Infrared heaters are also used for snow control, condensation control, and industrial process heating. Reflectors are frequently used to control the distribution of radiation in specific patterns.

When infrared is used, the environment is characterized by:

l. A high-temperature directional radiant field created by the infrared heaters
2. A low-temperature radiant field consisting of the walls and/or enclosing surfaces
3. Ambient air temperatures often lower than those found with conventional convective heaters.

Convection heat loss from the radiantly heated floor, sealed objects, and the radiant heat source increases the ambient temperature. Ultimately, the combined action of these factors determines occupant comfort and thermal acceptability of the environment.

ENERGY CONSERVATION

Infrared heating units are effective for spot heating. However, because of efficient performance, they are also used for total heating of large areas and entire buildings (Buckley 1989). Radiant heaters transfer energy directly to solid objects. Little energy is lost during transmission because air is a poor absorber of infrared energy. Since an intermediate transfer medium (such as air or water) is not needed, fans or pumps are not required.

As infrared energy warms floors and objects, they, in turn, release heat to the air by convection. Reradiation to surrounding objects also contributes to the comfort in the area. An energy saving advantage is that radiant heat can be turned off when it is not needed; when it is turned on again, it is effective in minutes.

Human comfort is determined by the average of mean radiant and dry-bulb temperatures. With radiant heating, the dry-bulb temperature may be kept lower for a given comfort levelthan with other forms of heating (ASHRAE 1981).As a result, the heat lost to ventilating air and via conduction through the shell of the structure is proportionally smaller, as is energy consumption. Infiltration, which is a function of temperature, is also reduced.

In some situations, radiant heating savesenergy by reducing the temperature stratification from the equipment to the floor.

Buckley and Seel (1987) compared energy savings of infrared heating with other types of heating systems. A New York State report (1973) identified annual fuel savings as high as 50%. Recognizing the reduced fuel requirement for these applications, Buckley (1988) notes that it is common for manufacturers of radiant equipment to recommend installation of equipment with a rated output that is 80 to 85% of the heat loss calculated by methods described in Chapter 25 of the 1989ASHRAE *Handbook-Fundamentals.*

INFRARED ENERGY GENERATORS

Gas Infrared

Modern gas-fired infrared heaters burn gas to heat a specific radiating surface. The surface is heated by direct flame contact or with combustion gases. Studies bythe Gas Research Board of London (1944), Plyler (1948),and Haslam *et al.* (1925) reveal that only 10 to 20% of the energy produced by open combustion of a gase-ous fuel is infrared radiant energy, whereas wavelength span can be controlled by design. The specific radiating surface of a properly designed unit increases radiant release efficiency and directs radiation toward the load. Heaters are available in the following types (see Table 1 for characteristics):

Indirect infrared radiation units (Figures la, Ib, and Ie) are internally fired and have the radiating surface between the hot gases and load. Combustion takes place within the radiating elements, which operate with surface temperatures up to 1200ºF. The

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