CHAPTER 8
INSULATION

8.1 INTRODUCTION*

Ever since the oil crisis of the 1970s, demand for energy-efficient buildings has been steadily rising. Model building codes have already adopted many energy conservation provisions; federal regulations such as the Energy Policy Act of 1992 also emphasize energy-efficient building construction. To set uniform design requirements for energy conservation, American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) has issued its Standard 90.1,[1] that is being rapidly adopted by building codes. The 1999 edition of this standard considers metal building roofs and walls as distinct elements of the building envelope.

Historically, insulation issues have not been on the "front burner" of the metal building industry. Indeed, inadequate insulation is still among the most often heard complaints about pre-engineered buildings. This chapter reviews some available insulation products, systems, and details to help designers make educated choices about materials and installation methods. It will not delve too deeply into the domain of HVAC engineers, dealing with thermal loads, energy conservation, and equipment selection topics. It will also avoid the matters of mass consideration, annual heating loads, and life-cycle costing for metal building systems that are well addressed in *Metal Building Systems* by the Building Systems Institute.[2]

8.2 THE BASICS OF INSULATION DESIGN

Heat loss or gain in a building can occur via three modes: radiation, conduction, and convection. Of these, conduction through the building envelope accounts for most heat transfer. Heat losses due to conduction can be reduced—but not eliminated—by additional insulation. Convection by air leaks can and should be prevented by "tightening" the building. Radiation affects mostly glass surfaces and can be minimized by reflective coatings. Since exterior walls contain openings and are otherwise thermally nonuniform, heat transfer via several parallel heat flow paths may be considered separately.

The building codes and ASHRAE 90.1 specify a certain required level of thermal conductance (or transmittance) U_0 for roof and wall assemblies in various locales, expressed in Btu/(h)(ft^2)(°F). Thermal transmittance is a reciprocal function of the thermal resistance R of an assembly, which is a sum of R values of the components including those of the inside and outside air films and any air cavities.

Heat transfer is often accompanied by moisture movement, since warmer air contains more water vapor than cold air. Movement of vapor does not have to coincide with the actual movement of the air containing it. When warm air cools down or meets a cool surface, it loses some of its moisture, producing condensation. The air temperature at which condensation starts to occur is the *dew point.*

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