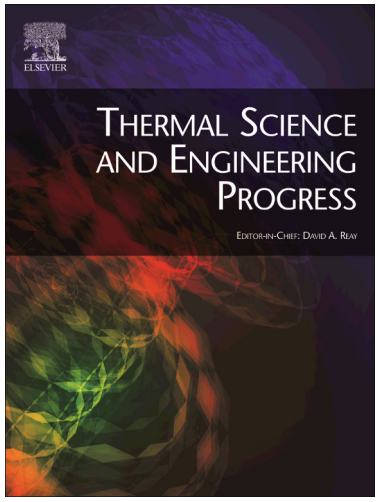

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Temperature and Heat Flux at Residential Surfaces due to Solar-Beam Radiative Selectivity, Geography/climate, Insulation/structural Configuration, Humidity, and Sky Condition

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Abstract

Extensive recent published literature has shown that the use of selectively highly reflecting coatings for solar beam radiation incident on roof surfaces during the summer has increased the solar albedo and decreased the need for electricity consumption to maintain building temperatures. In this paper, other issues relevant to the temperatures, heat fluxes, and human comfort related to solar energy are addressed. In particular, numerical simulation is used to focus on limited locations in the United States (Phoenix, AZ, Miami, FL, and Minneapolis, MN) for mid-summer and mid-winter climatic conditions. At these locations, two different insulation systems relevant to residential housing in the United States are considered. Not only is solar beam radiation taken into account, but also is infrared sky radiation, humidity of the surrounding air, cloud cover, air temperature, and the emissivity of water vapor droplets. The results presented include: (a) diurnal temperature and heat flux variations at the exterior surfaces, (b) temperatures and heat fluxes at internal surfaces, (c) heat flowing from the internal surfaces, (d) an accounting of the heat transferred respectively by conduction, convection, and radiation at the exterior surface, (e) convective heat transfer coefficients at the exterior surface. The results are presented over a 24-hour period on both June 21 and December 21. Equal focus was given to summer-season and winter-season performance of the radiatively selective coating. It was found that although the coating was highly advantageous for summer conditions, it significantly increased the power requirements for winter heating.

Keywords: Wavelength-selective paints, Building heat transfer, Passive cooling, Solar radiation

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