Mechanical Engineering Thesis Defense

Comprehensive Study of Radiative Sky Cooling Effect for Visibly Transparent, High-Emissivity Glass Windows

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Abstract

Windows are one of the most significant locations of heat transfer through a building envelope; in warm climates, it is important that heat gain through windows is minimized. Heat transfer through a window glazing occurs by all major forms of heat transfer (convection, conduction, and radiation). Convection and conduction effects can be limited by manipulating the thermal properties of a window's construction. However, radiation heat transfer into a building will always occur if a window glazing is visibly transparent. In an effort to reduce heat gain through the building envelope, a window glazing can be designed with spectrally selective properties. These spectrally selective glazings would possess high reflectivity in the near-infrared (NIR) regime (to prevent solar heat gain) and high emissivity in the atmospheric window, 8-13µm (to take advantage of the radiative sky cooling effect).

The objective of this thesis is to provide a comprehensive study of the thermal performance of a visibly transparent, high-emissivity glass window. This research proposes a window constructed by coating soda lime glass in a dual layer consisting of Indium Tin Oxide (ITO) and Polyvinyl Fluoride (PVF) film. The optical properties of this experimental glazing were measured and demonstrated high reflectivity in the NIR regime and high emissivity in the atmospheric window. Outdoor field tests were performed to experimentally evaluate the glazing's thermal performance. The thermal performance was assessed by utilizing an experimental setup intended to mimic a building with a skylight. The proposed glazing experimentally demonstrated reduced indoor air temperatures compared to bare glass, ITO coated glass, and PVF coated glass. A theoretical heat transfer model was developed to validate the experimental results; the results of the theoretical and experimental models showed good agreement.

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Zoom Link: https://asu.zoom.us/j/89095681392