Variations of Thermal Conductivity of Insulation Materials Under Different Operating Temperatures: Impact on Envelope-Induced Cooling Load

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Abstract: The thermal and energy performance of buildings depends on the thermal characteristics of the building envelope, and particularly on the thermal resistance of the insulation material used. The performance of the thermal insulation material is mainly determined by its thermal conductivity, which describes the ability of heat to flow across the material in the presence of a differential temperature. The value of the thermal conductivity of a particular material is subject to variation, due to changes in both moisture content and temperature. In reality, thermal insulation in buildings is exposed to significant and continuous temperature variations, due to varying outdoor air temperature and solar radiation. However, when calculating cooling loads or performing energy analyses for buildings, most designers, if not all, use published or manufacturer-supplied values of thermal conductivity, which are normally evaluated at 24°C according to the ASTM standards. Currently, many types of insulation materials are produced in Saudi Arabia, but not enough information is available to evaluate their performance under the prevailing climatic conditions. The objective of this paper is to present the results of a study that investigates the relationship between the temperature and thermal conductivity of various types of locally produced insulation materials. Additionally, the impact of thermal conductivity variation with temperature on the envelope-induced cooling load for a theoretically modeled building is quantified and discussed. Results are expected to clarify the issue of thermal conductivity dependence on temperature and lead to a more accurate assessment of the thermal and energy performance of buildings.

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