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ABSTRACT

The aim of this work is to demonstrate the potential thermal, environmental and cost advantages of a thermal insulation, which consists on several air chambers between layers of an insulation material with low infrared emissivity. The multimodal heat transfer involved (conduction, convection and radiation) is modeled and numerically solved for different materials and designs. The first design proposed uses multiple EPS layers of 1cm thickness separating air chambers. It achieves global thermal transmittances ranging from 0.439 W/(m^2·K) to 0.126 W/(m^2·K) for 4 to 13 layers, respectively. In this way, material savings up to 55% were obtained with respect to the solid EPS insulation, leading to lower embodied impacts and cost. A second design, based on thin 0.3 cm MDF panels coated with low-emissivity paint, gave thinner walls than the previous one, but higher embodied impacts and cost. A third design, based on EPS separation layers coated with very low emissivity aluminum foil, leads to significant improvements in all aspects considered. For a given total transmittance of 0.1 W/(m^2·K), this design reaches savings of 77% in material, 66% in cost, 72% in embodied impacts, and 38% reduction in wall width with respect to solid EPS insulations.