

Experimental investigation on the performance of solar chimney for reduction of vehicle cabin soak temperature

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Abstract

Vehicle cabin soak temperature is dire and in some cases is a life-threatening for any living organism trapped inside it. Also, it dictates the thermal comfort level upon entry, air conditioning (AC) load, and fuel consumption. This study is the first attempts to experimentally evaluate the impact of integrating a solar chimney (SC) on a vehicle exposed to direct sunlight in terms of its cabin soak temperature (CST), thermal comfort, AC power, and driving ranges. Therefore, outdoor thermal soak tests on two identical vehicles were carried out. The results confirmed a significant reduction of the soak cabin temperature, decreasing the cabin soak air temperature by 20.5 °C (max). This reduction can lead to a significant effect on the initial thermal solar loads, thereby exposure time to high temperature environment (thermal stress and anxiety) can significantly be reduced, while also enhance interior air quality, improve vehicle fuel economy, an 85% reduction in compressor power, increasing driving range by 26.25 km within the city drive cycle and 17.5 km on the highway cycle while operating the AC system, and reduce tailpipe emissions while preserving the integrity of the cabin's interior from cracking and fading. It can be concluded that the proposed strategy is able to achieve the highest cabin temperature reduction ever compared to other passive approaches.