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Experimental Analysis of Car Body Covers for Heat Penetration

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Abstract: With the increase in the number of private vehicles in today's lifestyle, it is common to park your car in direct sunlight due to the unavailability of shaded areas. However, this direct sunlight exposure can result in a greenhouse effect inside the car, leading to a rise in the temperature of the car cabin. In the current market, there are several body covers available for vehicles that mainly aim to repel dust and water. However, in this scenario, we are working on developing a thermal insulating body cover that addresses the issue of the greenhouse effect in the car cabin. we are also testing the existing UV-resistant and dust-proof covers for their insulation capacity. During the experimentation phase, we exposed the car to direct solar radiation while it was covered with dust-proof, UV-resistant material's cover. This was done to test the insulation capacity of the materials of the existing covers. In the experimentation phase, it was discovered that the dust-proof and UV-resistant cover material was unable to prevent heat from entering the car cabin. hence, it can be concluded that the body covers currently available in the market are insufficient in addressing the problem of the greenhouse effect in cars. To solve this issue, the development of thermal insulation cover is necessary.

Keywords:

I. INTRODUCTION

The temperature inside a parked car can rise quickly up to an average of 80℃ [1], especially if it is in an open or unshaded area on hot sunny days [1-4]. The internal temperature of the cabin increases to such a high temperature that it can damage the interior of the car and even affect passengers when present inside the cabin [5]. This is the most common problem which is faced by many people. The interiors of the car are mainly made of plastic parts, they get degraded because of the increase in temperature. In India, 23 out of the 40 fatalities during 2011-2020 were due to heatstroke caused by hyperthermia from being inside a vehicle parked under direct sunlight [6]. The sunlight can easily enter the vehicle's cabin when parked directly under the sun, it travels as shortwave radiation and it can easily penetrate through the glass window. This radiation, heats the vehicle and the heat which is generated cannot escape the cabin, as it is now converted into longwave radiation. This trapped heat is the reason that increases the vehicle's internal temperature. To decrease this increased temperature, the driver either lowers the windows or turns on the air conditioning at full speed, due to which affects the fuel consumption and overall performance of the vehicle [7].

The problem of overheating car interiors can be solved by using an insulating cover for cars. Currently, existing body covers promise to be UV-resistant and dustproof, but their heat resistance capabilities need to be tested.

The purpose of this paper is to evaluate the heat-resistant capabilities of the current car body cover to reduce the greenhouse effect inside the car. Additionally, the paper aims to propose an improved solution to address the issue of the greenhouse effect.

Table. 1 IR Thermometer Specifications

Model	HT-826
Temperature	-50℃ to 550℃
Range	-58℉ to 1022℉
Accuracy	±2% of reading
Optical Resolution	12:1 distance-to-spot size ratio

Fig. 1 IR Thermometer

A. Solar radiation condition

II. EXPERIMENTAL SETUP

B. Vehicle selection

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The vehicle chosen in this study is a 1497 cc, nationally subcompact crossover SUV car (XUV300).

C. Test Area

The test area was the car park of a private residential area at Tarnaka, Hyderabad, India (Latitude. 17.42°, Longitude. 78.54°). The test vehicle was oriented East (facing approximately 180° E), to ensure maximum sun load on the front windscreen and rear window.

D. Test period and time

The tests were performed on 3 different days with possibly minimum clouds, from September until mid-November 2023. The time interval selected for the tests is from 9:10 AM to 3:30 PM, as the sun load within this period is at the highest.

E. Test equipment and measurements

We used an infrared thermometer to manually measure the temperature at different spots in the vehicle. such as the dashboard, steering wheel, driver seat, and co-passenger seat.

The tests were performed in Hyderabad city for good solar radiation exposure of the car. The collected data of the three days of solar radiation is shown in Fig. 1.

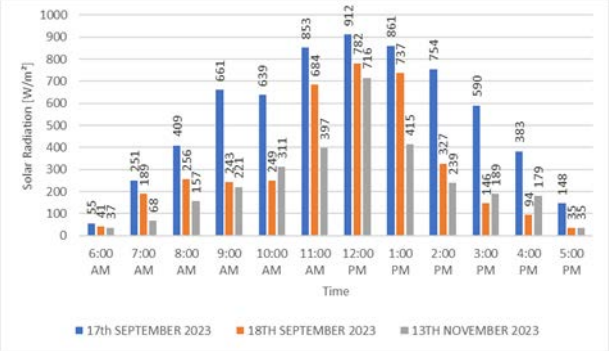

Fig. 2 Solar Radiations of the Test days

III. EXPERIMENTAL PROCEDURE

Initially, the test vehicle was parked in a shaded area. Later, around 8:40 am, it was driven to a test area and parked under direct sunlight. We manually recorded the readings in a notebook approximately every hour, starting from 9:10 am and stopping at around 3:15 pm. We repeated this process for three different cases. which are:

A. Case 1:

During the first case of the test, the vehicle that we used for testing was fully covered with a silver-coloured UV-resistant polyester cover. This cover was extended from the front bumper to the rear bumper and had dimensions of 3,995 mm in length, 1,821 mm in width, and 1,627 mm in height. The test was performed on 17th September 2023 under high solar radiation as shown in Fig. 1.

Fig. 3 Test car with UV- resistant cover

B. Case 2:

During the second case of the test, the vehicle for testing was fully covered with dust and waterproof matt cover. This cover was extended from the front bumper to the rear bumper and had dimensions of 3,995 mm in length, 1,821 mm in width, and 1,627 mm in height. The test was performed on 18th September 2023 under moderate to low solar radiation.

Fig. 4 Test car with dust-proof matt cover

C. Case 3:

During the third case of the test, two vehicles were simultaneously used with UV-resistant and dust-proof matt cover. This test was performed on 13th November 2023 under moderate to low solar radiation as shown in Fig. 1.

IV. RESULTS & DISCUSSIONS

The maximum temperature difference between the dashboard, steering wheel, passenger seat and driver seat are presented in Fig. 5 with respect to the ambient temperature at that time.

The maximum temperature difference between the car cabin and the ambient temperature was recorded at the dashboard, reaching 10.5℃ while the car was covered with UV-resistant body cover during case 1.

In case 2, we observed a maximum temperature difference of 5.2℃. The difference was noted at the driver's seat while the car was covered with dust and waterproof mat cover. However, the temperature difference was of less value due to the lower intensity of solar radiation during the day refer to Fig. 2.

In case 3, during the experiment, we found that the car 1 with UV-resistant cover had a maximum temperature difference of 3.9℃ at the dashboard. On the other hand, car 2, with dust and water-proof mat cover, had a maximum temperature difference of 3.2℃ at the steering wheel and the driver's seat. It is worth noting that the temperature difference was lower for both cars during the month of November due to less intensity of solar radiation refer to Fig. 2.

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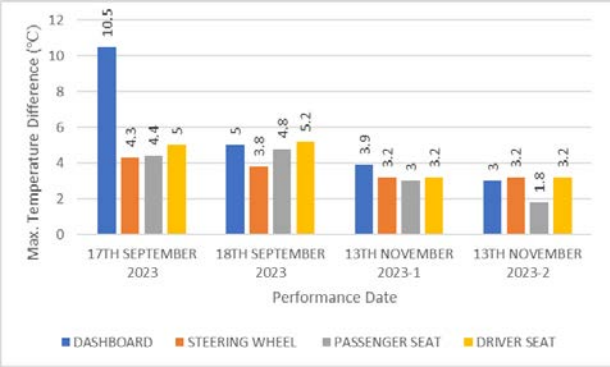

Fig. 5 Max. Temperature difference of car components.

V. CONCLUSIONS

- It was observed that the UV-resistant and dust-proof body cover used for experimentation analysis did not insulate the car cabin from solar radiation.
- It is important to note that the current existing body covers available in the market are only suitable for protecting cars from dust and water only. Hence, these covers do not provide a sufficient solution for overheating problems that occur when cars are parked in direct sunlight.
- It is necessary to design a thermal insulation cover for vehicles that can provide the best solution for car cabin heating problems.

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