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Vehicle temperature identification based on vehicle dimensions during vehicle parking

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Abstract

Increased car temperature when parked in sunlight results in discomfort for the driver and passengers, and can damage the inside the car, including the dashboard, seats, and control panel. Research This study was conducted to measure the increase in vehicle cabin temperature when parked in the sun from 08.20 - 16.20 WIB. This research aims to compare the test results between the two objects studied, namely cabin temperature increase in avanza type G 1.3 year 2010 and innova type G 2.0 year 2010. Data was collected using data logger gauges placed at four points in the vehicle cabin. four points in the vehicle cabin. The results showed that the highest cabin temperature was achieved by the Avanza vehicle with the highest hot spots at sensor 1 and sensor 2, while the highest CO levels were at a certain point during the test. The dimensional factor of the vehicle was shown to affect the temperature rise and heat distribution in the cabin. The implication of this research is the need to develop vehicle thermal management technology to reduce the impact of extreme heat on the cabin as well as health risks due to toxic gases.

Keywords

Vehicle temperature, Vehicle dimension, Thermocouple

Introduction

Vehicles parked in the sun often have a hotter cabin space caused by solar heat absorbed by the vehicle, the increase in temperature inside the vehicle can cause several problems such as thermal discomfort, damage to the vehicle interior, increase the need for air conditioner use and fuel consumption. In addition, toxic gases are produced as a result of the vaporization process which results in increased health risks for drivers and passengers in the vehicle cabin. The toxic gases produced are carbon monoxide (CO) and ammonia (NH3). Ammonia gas (NH3) is corrosive and irritating which can cause burns in the nose, throat, and airway and can cause lung damage and death due to the process of solar heat transfer absorbed by the vehicle when parking [1].

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Vehicles parked under the sun during the day can experience an increase in cabin temperature due to trapped solar radiation, causing potential damage to the steering wheel, seats, dashboard and other interior parts [2]. In part, the resulting impacts such as improving driver comfort also improve safety, increase alertness, and good thermal management lead to improved e-driving [3].

Previous research has made various efforts to overcome the problem of increasing vehicle cabin temperature when parking in the sun. Used a solar panel-based cabin cooling system that was proven to be able to reduce cabin temperature by 9.8°C and reduce the heat index to a safer level. However, this technology faces obstacles in its operational efficiency during cloudy weather [2]. Examined the effect of the darkness level of window film on heat transfer to the cabin [4]. The results show that dark window films effectively reduce heat but impact visibility, especially at night, which is a significant drawback. The importance of interior materials and ventilation design in managing cabin temperature for thermal comfort [3]. However, previous studies tend to ignore the influence of vehicle dimensions as an important factor affecting the rate of temperature rise.

This study offers a new approach by focusing on analyzing vehicle dimensions (length, width, height) and their relationship with cabin temperature increase. By using data logger measurement devices at various strategic points in the cabin, this approach also considers the levels of toxic gases such as carbon monoxide that can arise under extreme conditions. The results of the study are expected to provide more comprehensive vehicle design guidelines to improve user comfort and safety.

Method

This research uses an experimental method. The experimental research method is a research method used to find the effect of certain treatments on others in a controlled condition [5]. This study aims to determine the temperature of the vehicle based on the dimensions of the vehicle during parking. The research implementation begins with preparing materials and test equipment such as test vehicles, thermocouples, and data loggers. Direct data collection for 3 times the experiment. The research objects used in this study are avanza type G 1.3 year 2010 and innova type G 2.0 year 2010. The research pattern can be seen in Figure 1.

Two cars used in the test, namely avanza type G 1.3 year 2010 and innova type G 2.0 year 2010 will be placed in an area exposed to direct sunlight. The test was carried out in the parking lot of Padang State University Auditorium starting from 08.20 - 16.20 WIB. The placement of sensors 1 to sensor 4 in the test are: sensor 1 is placed in the center of the front dashboard, sensor 2 is placed in the center of the front seat, sensor 3 is placed in the center of the middle seat, and sensor 4 is placed in the center of the back seat, For the placement of temperature sensors in the cabin can be seen in Figure 2.

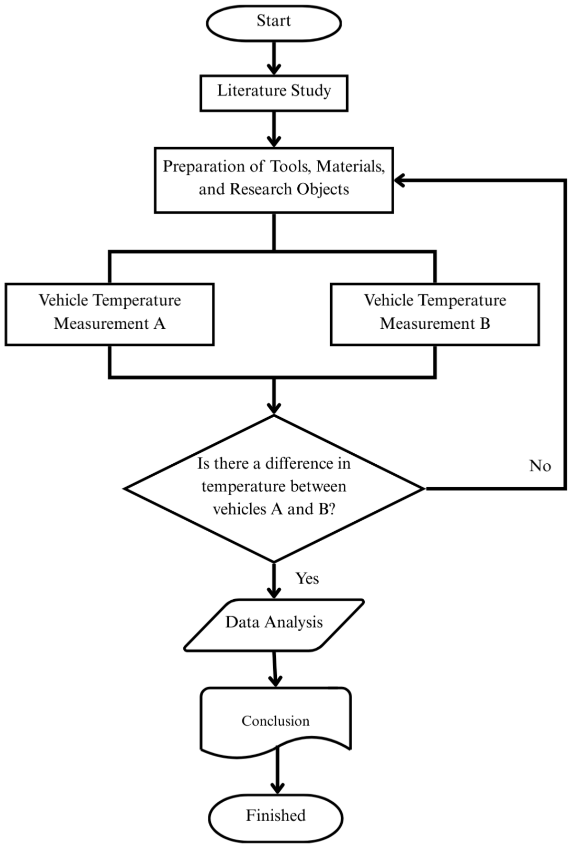

Figure 1. Research flow

Figure 2. Temperature sensor placement in the cabin

Data analysis technique

This data analysis is used to measure vehicle temperature based on vehicle dimensions while parked under sunlight.

$$\mathrm{M} = \frac{\sum x}{n} \qquad (1)$$

Description: M as Mean (Average); $\sum x$ as Number of data; n as Number of data

Then present the average value of each statistical test

$$\mathrm{P} = \frac{\mathrm{N}-\mathrm{n}}{\mathrm{N}} \times 100\% \qquad (2)$$

Description: P as Percentage number obtained; n as After treatment ; N as Before treatment

Compare the test results between vehicles with dimension A and vehicles with dimension B, the results of which will be presented in graphical form.

Results and Discussion

Results

The thermal and air quality conditions within the cabin are illustrated through Figures 3 to 5. Figure 3 presents a comparison of cabin temperature rise, highlighting the differences in thermal accumulation over time. Figure 4 depicts the cabin humidity levels, providing insight into moisture variation under different conditions. Meanwhile, Figure 5 shows the concentration of CO (carbon monoxide) inside the cabin, which serves as an important indicator of air quality and potential health risks.

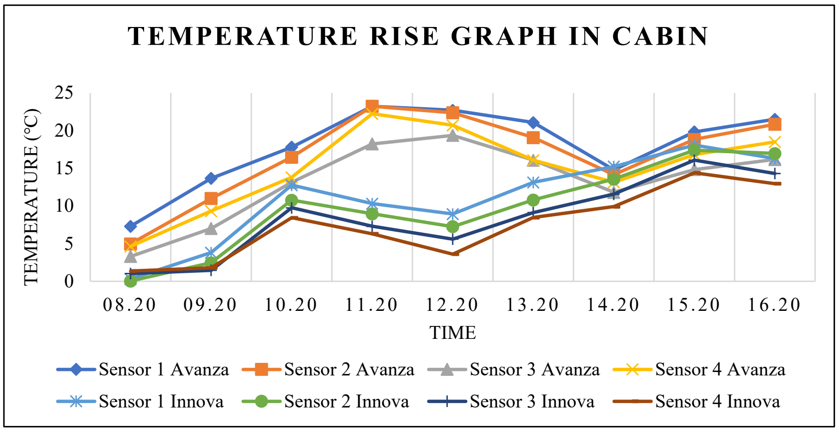

Figure 3. Cabin temperature rise comparison

Avanza experienced a higher temperature rise than Innova, with peak temperatures recorded at 11.20 for Avanza and 15.20 for Innova.

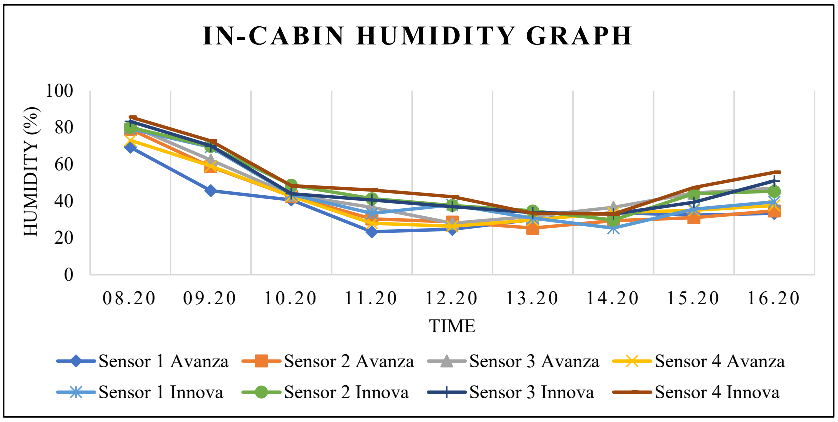

Figure 4. Cabin humidity graph

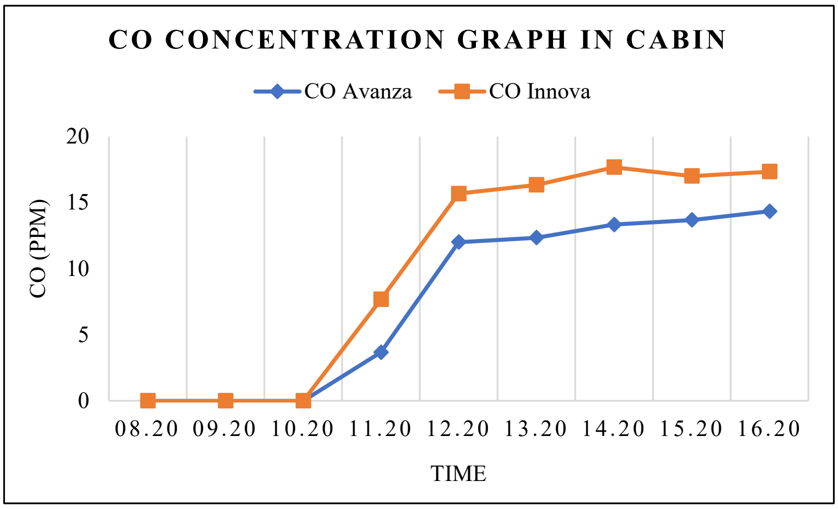

Figure 5. CO concentration graph

Innova vehicles have higher levels of CO compared to avanza, the percentage of increase in CO concentration in innova compared to avanza is 32%.

Discussion

Based on the results of the research on the two test vehicles, it can be seen that there is an increase in cabin temperature from the outside temperature, this is due to radiation from solar heat, some radiation will be reflected, absorbed, and forwarded. Radiation absorbed by the glass and interior surfaces of the vehicle will make the temperature in the cabin increase. The standard glass used in Avanza absorbs and transmits heat from sunlight into the cabin. The highest increase in cabin temperature is found in the Avanza, because the smaller cabin size causes faster heat accumulation.

This research provides a new perspective in vehicle thermal studies by highlighting the relationship between vehicle dimensions, heat distribution, humidity and CO levels, which has not been explored in previous studies. In addition, this study is more specific in exploring the health consequences of toxic gas accumulation in the cabin.

Conclusion

There is a difference in the temperature of the four sensors installed in the cabin of the Avanza and Innova vehicles. Sensors 1,2,3 and 4 in the innova vehicle have cabin temperatures of 48.59 ° C, 47.41 ° C, 45.89 ° C and 44.78% with a percentage increase in outside temperature of 29%, s26%, 22% and 19%. In Avanza vehicles, sensors 1, 2, 3 and 4 have cabin temperatures of 52.85 ° C, 51.63 ° C, 48.18 ° C and 49.89 ° C with a percentage increase in outside temperature of 52%, 48%, 38% and 43%. In Avanza the average temperature increase is 15.78 ° C with a percentage of 45.25% while in Innova the average cabin temperature increase is 9.06 ° C with a percentage of 24%. From the data obtained on both vehicles, the highest temperature in each vehicle cabin is the front cabin on sensor 1 and sensor 2. Comparison of temperatures between avanza and innova vehicles is that avanza vehicles have a higher temperature increase during parking under sunlight.

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References

[1] F. Purwanto, "Perancangan dan Implementasi Sistem Monitoring Gas Berbahaya pada Mobil berbasis Logika Fuzzy Menggunakan Mikrokontroler," e-Proceeding of Engineering : Vol.3, No.3 December 2016, vol. 3, p. 4657, 2016.

[2] M. Setiyo, B. Waluyo, N. Widodo, M. L. Rochman, S. Munahar, and S. D. Fatmaryanti, "Cooling effect and heat index (HI) assessment on car cabin cooler powered by solar panel in parked car," Case Studies in Thermal Engineering, vol. 28, no. August, p. 101386, 2021, doi: 10.1016/j.csite.2021.101386.

[3] G. J. Marshall, C. P. Mahony, M. J. Rhodes, S. R. Daniewicz, N. Tsolas, and S. M. Thompson, "Thermal Management of Vehicle Cabins, External Surfaces, and Onboard Electronics: An Overview," Engineering, vol. 5, no. 5, pp. 954–969, 2019, doi: 10.1016/j.eng.2019.02.009.

[4] A. Nur Setya Budi, I. Qiram, and D. Sartika, "Pengaruh Prosentase Kepekatan Kaca Film Terhadap Distribusi Termal dan Pencahayaan Kabin Kendaraan," V-MAC (Virtual of Mechanical Engineering Article), vol. 6, no. 1, pp. 1–4, 2021, doi: 10.36526/v-mac.v6i1.1293.

[5] Sugiyono, Metode Penelitian Kuantitatif, Kualitatif Dan R&D. 2017.