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Effect of Tire Pressure Factor Toward Fuel Consumption of Passenger Vehicle

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Air pollution, tire pressure, fuel consumption

Abstract

Total amount of cars on street is increasing and it concern the scientist, politician and the public regarding the air pollution is caused. Air pollution due to motorized vehicles can be harmful to the environment and humans. The main objective of the project is to find out how the tire pressure effects the fuel consumption of passenger car. Perodua Myvi was used in this experiment to measure fuel consumption at various tire pressures which are 170, 210, 250 kPa. This experiment conducted in UTHM Pagoh where the road stretch to 4.7 km but the desired distance is 51.7 km so, the driver has to drive 11 times around UTHM Pagoh road. This experiment conducted at least three times at different tire pressure and after each test drive the fuel consumption was recorded using On-Board Diagnostic II (OBD II) under dry weather.

1. Introduction

Air pollution is a persistent and ongoing problem caused mainly by the widespread use of motor vehicles in metropolitan areas, which contribute significantly to the air pollution problem, which can have serious consequences for both human health and the environment. Despite efforts to address this issue, air pollution caused by motor vehicle emissions remains a pressing concern that requires ongoing attention and efforts to mitigate its negative impacts. The problem of air pollution caused by motor vehicle emissions was first identified in Los Angeles, California in the 1940s and it is estimated that over 45% of the nearly 6 billion people in the world will live in urban areas, where air pollution from motor vehicles is a major contributor to physical and mental health problems for people and the environment. With transportation being the main source of toxic air pollutants and motor vehicles being recognized as the main source of air pollutants in cities, it is important to continue efforts to mitigate the negative impacts of air pollution caused by motor vehicle emissions. [1]

2. Sensor and Methods

2.1 Sensor

There are many sensors was used to run this experiment successfully which are:

i. HH OBD advanced car diagnostic scanner code reader scan tool for Android

Fig. 1 *HH OBD advance*

The HH OBD advance sensor was chosen for the experiment because it is provided by Bengkel Teknologi, FTK, UTHM, which means that no external party needs to be involved in obtaining the sensor. The sensor is connected to the car by plugging it into the OBD port, which is typically located under the dashboard of the vehicle. The sensor then communicates with the phone via Bluetooth, allowing for the display of specific data and recording of that data using the torque app. This sensor is easy to use and extract data, once the data is recorded it can be easily converted into excel format as the system supports android and windows.

ii. PROSKIT NT-312 digital temperature and humidity meter with probe

Fig. 2 *PROSKIT NT-312 digital temperature and humidity meter with probe*

The PROSKIT NT-312 digital temperature and humidity meter with probe was chosen for the experiment because it is provided by Bengkel Teknologi, FTK, UTHM, which means that no external party needs to be involved in obtaining the testing vehicle. Additionally, the vehicle was chosen because it is suitable for the experiment's conditions as it will be run under dry conditions, where the temperature is more than 32 °C and humidity is less than 30%. This vehicle is also compatible with the sensor range used in the experiment and its accuracy is good to avoid inaccurate data collection.

iii. Perodua Myvi

Fig. 3 *Perodua Myvi*

The Perodua Myvi vehicle was chosen for the experiment because it is provided by Bengkel Teknologi, FTK, UTHM, which means that no external party needs to be involved in obtaining the testing vehicle. Additionally, this vehicle was chosen because it is widely used among Malaysian drivers, therefore, the data obtained can be used by both Malaysian drivers and manufacturers in the future. This will allow for the data to be relevant and useful for the Malaysian market, making it more applicable for improving fuel efficiency and reducing emissions in the country.

2.2 Flowchart

Meshing is the most important step in a flow simulation analysis. An enclosure which represents as wind tunnel will be designed in dimension of 8000 x 12000 x 4000 mm [2]. The fluid domain then setup-up in CFX Solver. The meshing of the model is done in ANSYS software shown in Fig. 4.

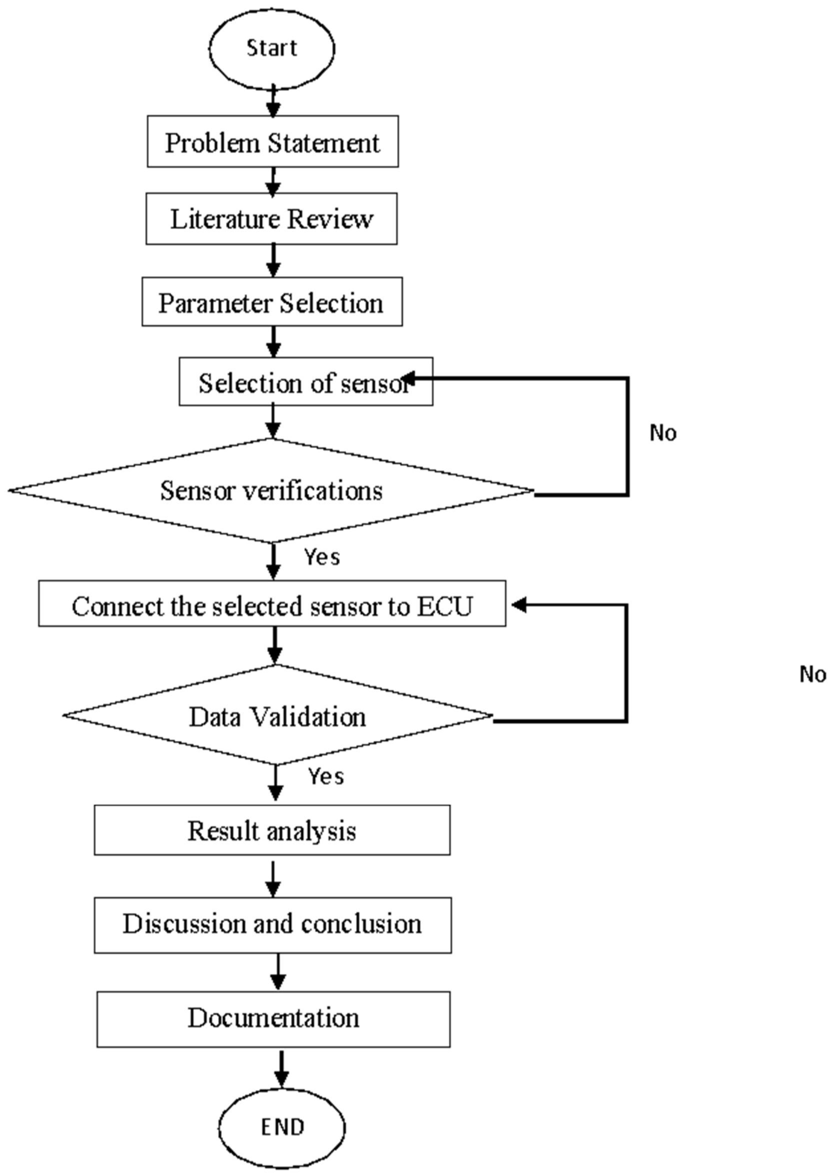

Fig. 4 *Flowchart*

There are several scopes for this experiment which are;

1. On-Board Diagnostic II (OBD II) was used to measure the fuel consumption of the passenger vehicle.
2. The passenger vehicle for this experiment was conducted by using Perodua Myvi 1.3 L provide by Bengkel Teknologi, FTK, UTHM. This passenger vehicle is equipped with 175 / 65, tire size with rim size are 14 inches.
3. The tire pressure in this experiment was 170, 210, 250 kPa which is 210 kPa is the standard tire pressure suggested by manufacture while 170 kPa and 250 kPa are low and high category of tire pressure.
4. RON (95) represent as a fuel type that was used in this experiment.
5. The study was conduct in the area of UTHM campus Pagoh that cover around 51.7 km distance.
6. Only 1 driver was used to conduct this experiment.
7. This experiment ran under dry condition where the temperature has to be more than 32 °C and the humidity less than 30%.

This experiment procedure starts by setting the desired tire pressure. Next, the OBD II is connected to the ECU at the OBD port. Then the OBD II is connected to phone that has torque app via Bluetooth to collect the data of fuel consumption. Then the GPS Logger app is activated to take data of distance, average speed, and average time. Make sure the condition is in dry condition by checking the temperature and humidity using PROSKIT NT-312 Digital Temperature and Humidity meter with probe.

3. Results and Discussion

Table 1 *Results of the experiment*

	Experiment 1	Experiment 2	Experiment 3
Tire pressure (kPa)	170	210	250
Temperature (°C)	31.7	32.2	32.7
Humidity (%)	10	10	28
Time taken (hr : min)	1:40	1:39	1:41
Average speed (km/h)	30.8	31.1	30.7
Average fuel used (trip) (l)	1.9	1.43	1.41

The experiment shows that there is a correlation between tire pressure and fuel consumption. Lower tire pressure (170 kPa) resulted in higher fuel consumption (1.9 L), while higher tire pressure (210 or 250 kPa) resulted in lower fuel consumption (1.43 or 1.41 L). This suggests that maintaining proper tire pressure can lead to better fuel efficiency and reduce fuel consumption. According to a study conducted by Oak Ridge National Laboratory, underinflated tires can decrease fuel economy significantly; for example, at 50% of the recommended pressure, fuel economy can drop by about 10% at lower speeds [3]. Another study emphasizes that every 1 PSI drop in tire pressure can reduce gas mileage by approximately 0.2% [4]. Therefore, keeping tires inflated to their recommended levels is crucial for optimizing fuel efficiency [5-6].

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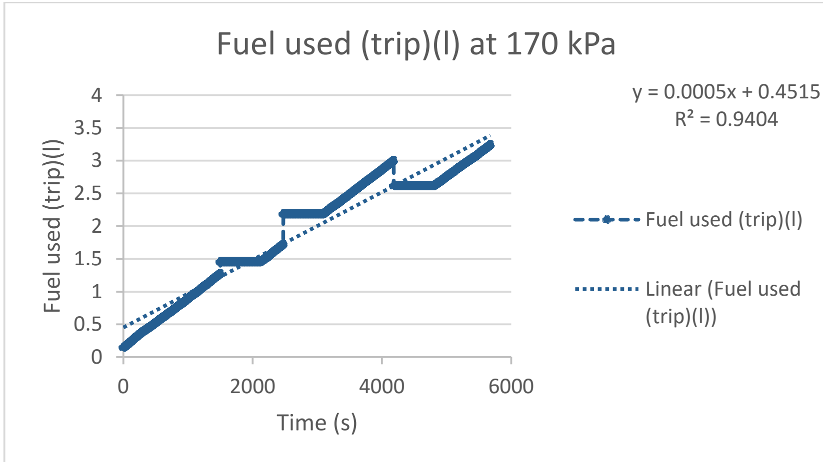

Fig. 5 *Regression graph fuel used (trip)(l) against time(s) at 170 kPa*

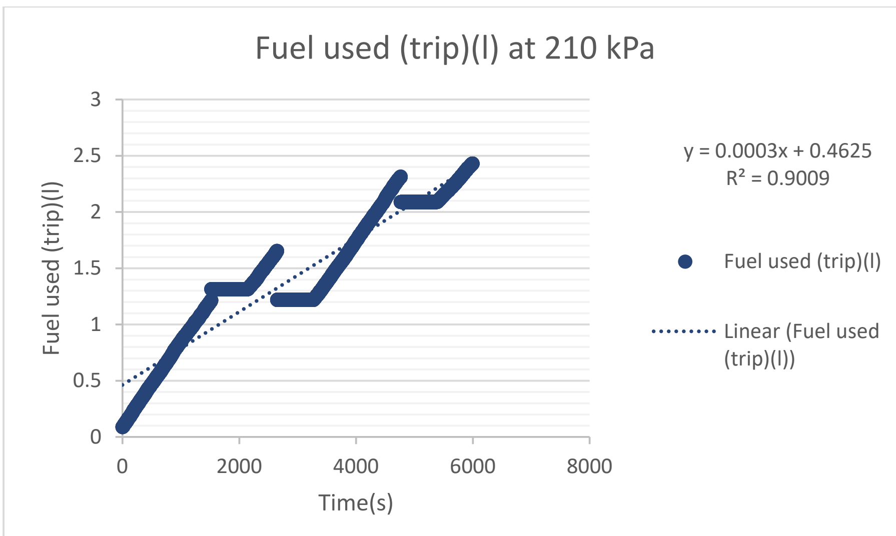

Fig. 6 *Regression graph fuel used (trip)(l) against time (s) at 210 kPa*

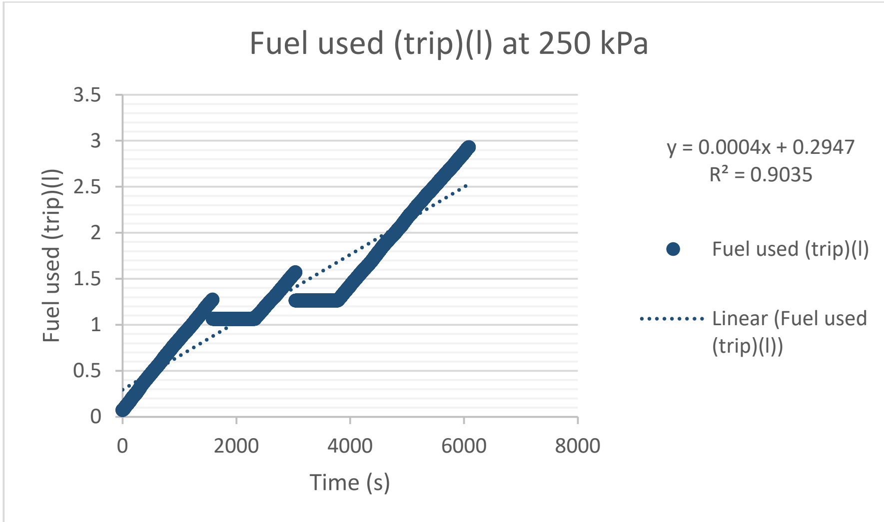

Fig. 7 *Regression graph fuel used (trip)(l) against time at 250 kPa*

As for the regression graph, there are three regression graphs for tire pressure of 170 kPa, 210 kPa and 250 kPa showing fuel used in a line graph. The slope of a line on a graph represents the rate at which the dependent variable (in this case, fuel consumption) changes in relation to the independent variable (time). In this scenario, the three different graphs represent fuel consumption at three different tire pressures: 170 kPa, 210 kPa, and 250 kPa. The slope of the graph at 170 kPa is 0.9404, which is the steepest of the three slopes. This indicates that for each unit of time, fuel consumption increases at a faster rate when the tire pressure is set at 170 kPa. The slope of the graph at 210 kPa is 0.9009, which is less steep than the slope at 170 kPa. This indicates that for each unit of time, fuel consumption increases at a slower rate when the tire pressure is set at 210 kPa. The slope of the graph at 250 kPa is 0.9035, which is also less steep than the slope at 170 kPa. This indicates that for each unit of time, fuel consumption increases at a slower rate when the tire pressure is set at 250 kPa. In summary, the difference in the slope of the three graphs represents the difference in fuel consumption at different tire pressures. A higher slope indicates a higher fuel consumption rate, while a lower slope indicates a lower fuel consumption rate. The slope of the graph at 170 kPa is higher than the slope of the graph at 210 kPa and 250 kPa, indicating that the fuel consumption rate is higher at a tire pressure of 170 kPa than at 210 kPa and 250 kPa [7].

4. Conclusion

To summarize, the objectives of the experiment were to study the effect of different tire pressures on fuel consumption, determine the fuel consumption of a passenger car with different tire pressures under dry conditions, and analyze the fuel consumption data obtained. The results of the experiment indicate that lower tire pressure leads to higher fuel consumption due to increased rolling resistance, while higher tire pressure leads to lower fuel consumption due to decreased rolling resistance. The experiment was conducted under dry conditions with temperatures more than 32°C and humidity less than 30% to maintain a constant variable. Finally, the fuel consumption data was analyzed by calculating the average fuel used per trip and creating a regression graph to ensure accurate data.

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Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design**: Premdip Singh s/o Koldip Singh; **data collection**: Premdip Singh s/o Koldip Singh; **analysis and interpretation of results**: Premdip Singh s/o Koldip Singh, Muhamad Asri bin Azizul, Syabillah bin Sulaiman; **draft manuscript preparation**: Premdip Singh s/o Koldip Singh; **Manuscript reviewing**: Muhamad Asri bin Azizul, Syabillah bin Sulaiman. All authors reviewed the results and approved the final version of the manuscript.*

References

Fark, D. M. (2002). *The effects of fine particulate air pollution from fossil fuel combustion and sustainable transportation* (Order No. MQ77738). Available from ProQuest Dissertations & Theses Global. (305472567). Retrieved from https://www.proquest.com/dissertations-theses/effects-fine-particulate-air-pollution-fossil/docview/305472567/se-2

Anderson, T. R., Hawkins, E., & Jones, P. D. (2016, July 25). CO2, the greenhouse effect and global warming: From the pioneering work of Arrhenius and Callendar to today's Earth System Models. Endeavour. Retrieved June 10, 2022, from https://www.sciencedirect.com/science/article/pii/S0160932716300308

U.S. Department of Energy, "Fact #826: June 23, 2014 - Effect of Tire Pressure on Fuel Economy," [Online]. Available: https://www.energy.gov/eere/vehicles/fact-826-june-23-2014-effect-tire-pressure-fuel-economy. [Accessed: Jan. 23, 2025]

JACO Superior Products, "Understanding the Impact of Tire Pressure on Your Vehicle's Fuel Efficiency," [Online]. Available: https://jacosuperiorproducts.com/blogs/news/understanding-the-impact-of-tire-pressure-on-your-vehicles-fuel-efficiency. [Accessed: Jan. 23, 2025]

F. Synák and A. Kalašová, "Assessing the Impact of the Change in the Tire Pressure on the Rolling Resistance and Fuel Consumption," Advances in Science and Technology Research Journal, vol. 14, no. 3, pp. 100–106, Sep. 2020. [Online]. Available: https://www.astrj.com/pdf-120801-53988?filename=Synak.pdf. [Accessed: Jan. 23, 2025].

S. Chandra, "Tire Inflation and Fuel Consumption," San Jose State University, [Online]. Available: https://transweb.sjsu.edu/sites/default/files/2006-Chandra-Tire-Inflation-Fuel-Consumption.pdf. [Accessed: Jan. 23, 2025].

S. Chandra and V. Balali, "A Study on Vehicle Tire Inflation and Fuel Consumption," San Jose State University, Project 2006, Feb. 2021. [Online]. Available: https://transweb.sjsu.edu/sites/default/files/2006-Chandra-Tire-Inflation-Fuel-Consumption.pdf. [Accessed: Jan. 23, 2025].