

## Research Article

### Relationship between Vehicle Manufacturers Recommended Tyre Pressure and Tyre Pressure Used by Vehicle Owners

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**Abstract:** This paper studies the relationship between the tyre pressures used by drivers and the vehicle manufacturers recommended tyre pressure. First of all, a survey of vehicles on Kwame Nkrumah University of Science and Technology (KNUST) campus was done to ascertain how tyre pressures of these vehicles deviate from the vehicle manufacturers recommended tyre pressures. Then the survey was extended to other four places namely, Kumasi Polytechnic campus, Asafo, Roman Hill and Kejetia bus depots. The survey showed that most of the vehicles tyre pressures deviate from the vehicle manufacturers recommended tyre pressure. Out of 660 vehicles surveyed in these five areas in the Kumasi Metropolis, 96.52% (637) had their tyre pressures deviated from the vehicle manufacturers recommended tyre pressures. That means only 3.48% (23) of these vehicles had their measured tyre pressures conforming to the vehicles manufacturers recommended tyre pressures. Most vehicles in the Kumasi Metropolis have their tyre pressures deviating from the vehicle manufacturers recommended tyre pressures. Strong education should be given to drivers on the need to use the correct tyre pressures.

**Keywords:** Tyre, tyre pressure, vehicle manufacturers recommended tyre pressure

## INTRODUCTION

In recent years, the increasing demand for the safety of an automobile has promoted research and development of the technology of active safety. One of the important factors determining vehicle dynamics including safety is tyre air pressure. A reduction in tyre pressure from the proper level will cause deteriorations in the driving stability, fuel consumption, tyre life and possible bursts of the tyres.

According to Hillier (1991) 'underinflation' or overloading leads to rapid wear on each side of the tread and internal damage to the casing, whereas 'overinflation' wears the centre of tread. Reed and Reid (2000) said that the major causes of over-inflation are an inaccurate tyre pressure gauge, hot tyres or incorrect reading by the operator.

If tyre pressure is too high, the tyre contact patch is reduced, which decreases rolling resistance. However, ride comfort is reduced, but traction is not always reduced, stopping distance is not always increased. Also, going above maximum sidewall pressure rarely results in the centre of the tyre wearing more than the shoulder.

If tyre pressure is too low, the tyre contact patch is increased, increasing rolling resistance, tyre flexing and friction between the road and tyre. This

"underinflation" can lead to tyre overheating, premature tread wear and tread separation in severe cases.

It is important that vehicle tyres are of the correct pressure for maximum economy (tyre wear and fuel consumption) and safety. That is the tyre should have the correct amount of tread in contact with the road for optimum grip and traction and also, the air in the tyre that supports the vehicle. It is important for vehicle users to note that when vehicle tyres are inflated to their correct pressures, the safety of the occupant is guaranteed, the fuel economy of the car is also enhanced as well as the comfortability is achieved (Reimpell and Stoll, 1996).

A survey on the tyre pressure conducted in the parking lot of a company shows that cars with low-pressure (under 140 kPa) tyres occupy about four percent and sixty four percent of these cars have four tyres with substantially equal pressures which is due to the natural leakage (Ohashi *et al.*, 1997). According to the statistics of Japan Automobile Federation (JAF), tyre problems on highways are the greatest number of cases in which the JAF is asked to rescue. This situation is caused by the difficulty for ordinary drivers to sense the reductions in the air pressures or because of the lack of interest in maintaining proper tyre air pressure.

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Similar results are found elsewhere in the world. For example, a recent study in Saudi Arabia found the pressure in 21% of the inspected tyres was 25% or more below the vehicle manufacturer's recommended inflation settings (Ratrouf, 2005). Tyres typically lose about one pound per square inch (psi) of air pressure per month during normal driving conditions and can lose considerably more during the change in ambient temperature (1 psi/10 °F drop). Under-inflated tyres decrease fuel economy, shorten tread life, have less lateral traction and longer stopping distances and prone to stress damage, which are more vulnerable to flat tyres and thus resulted in rollovers.

According to Hillier (1991), inflating correct tyre pressure can prevent tyres from overheating, explosion and on the other hand, ease motoring and reduce maintenance cost. The main problem therefore is, whether vehicle users are using the correct tyre pressure recommended by the manufacturers. This study seeks to find out how far the tyre pressures used by vehicle users deviate from the manufacturers recommended tyre pressures.

**Tyre pressure monitoring system:** Tyre Pressure Monitoring Systems (TPMS) are electronic systems that monitor the tyre pressures on individual wheels on a vehicle and alert the driver when the pressure goes below a warning limit. There are several types of designs to monitor tyre pressure. Some actually measure the air pressure and some make indirect measurements, such as gauging when the relative size of the tyre changes due to lower air pressure. These systems are becoming mandatory in countries such as the United States.

For example, to address challenges and safety concerns created by America's increased use of Sports Utility Vehicles (SUVs), the National Highway Traffic Safety Administration created and the US 106<sup>th</sup> Congress passed, the Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act (2000). The TREAD Act requires automobile companies to report defects in motor vehicles, tyres, or equipment and requires faulty equipment to be replaced or repaired at no cost to the consumer. The TREAD Act will also reduce energy use because it demands that manufactures install a Tyre Pressure Monitoring System (TPMS) in future automobiles. The deployment of TPMS, which consists of a tyre pressure sensor in each tyre, a logic circuit and a warning system for the driver, will reduce fuel use by assuring America's fleet is driving on properly inflated tyres. It has already been established that the average driver does not understand, monitor or correct vehicle tyre pressure (McKenzie-Mohr *et al.*, 1999; Jones, 2000).

**Importance of tyres:** Tyres are part of the backbone of a car, truck, piece of construction equipment or bicycle.

Tyres add traction, braking, steering and load support to vehicles while also absorbing shock and creating a smooth and comfortable ride. They are o-shaped parts that can be pneumatic or solid and fit around the wheels of the vehicle to protect the wheels and add to their effect. A solid tyre consists of rubber, metals and plastic parts (Williams, 2008). Vehicle tyres can affect not only the way car are handled, but also can affect the overall performance and fuel economy of a vehicle. One of the most important things to do is a regular schedule to check air pressure in tyres. Incorrect air pressure in tyre causes the tyre failure. Tyre failure while driving can lead to crush and possibly injure the driver and the passengers (Gibson, 2006).

## MATERIALS AND METHODS

A survey of vehicles was conducted in Kumasi metropolis. The survey was based on field data on vehicles from Kwame Nkrumah University of Science and Technology (KNUST) campus, Kumasi Polytechnic campus, Asafo, Roman Hill and Kejetia.

**Measurement of tyre pressure:** A survey was conducted to ascertain how far vehicles plying their trade on roads in Kumasi have tyre pressure deviated from the vehicle manufacturers recommended tyre pressure. Three public transport stations in Kumasi metropolis were taken into consideration namely Asafo, Roman Hill and Kejetia and two public institutions namely KNUST and Kumasi Polytechnic.

Initially, the survey was conducted in the transport department of KNUST. All the tyre pressures for each vehicle were measured using tyre pressure gauge and compared to the vehicle manufacturers recommended tyre pressure. The result is shown in Table 1.

From Table 1, the average tyre pressures in each vehicle for both measured and recommended were computed. The difference between the average measured tyre pressure and average recommended tyre pressure were then computed to establish the percentage deviation of the tyre pressure. The results are tabulated and presented in Table 2.

This was repeated for the remaining 10 units in the University. The tables of results are presented at appendix A. The results were grouped into ranges, that is (0.01-10) %, (10.01-20) %, (20.01-30) % and so on. The results obtained are tabulated and presented in Table 3.

From Table 3, it could be inferred that 98% of the vehicles deviated from the recommended tyre pressure. Only 2% conform to the recommended tyre pressure.

Hence, the survey was extended to Kumasi Polytechnic campus and three other public transport stations in the Kumasi Metropolis, which are, Asafo, Roman Hill and Kejetia to verify whether they have the same trend as obtained KNUST campus. Sixty vehicles were surveyed in Kumasi Polytechnic, 150 in Asafo,

Table 1: Measured tyre pressure of vehicles at transport department of KNUST

Vehicle	Measured Tyre Pressure (N/mm <sup>2</sup> ) (MTP)				Vehicle Manufacturers Recommended Tyre Pressure (N/mm <sup>2</sup> ) (VMRTP)			
	FR	FL	RR	RL	FR	FL	RR	RL
1	0.1792	0.1655	0.1655	0.2068	0.2068	0.2068	0.2206	0.2206
2	0.2620	0.2620	0.1655	0.1517	0.2551	0.2551	0.2965	0.2965
3	0.2758	0.2758	0.3378	0.3378	0.3516	0.3516	0.4482	0.4482
4	0.1310	0.1310	0.1517	0.2068	0.2137	0.2137	0.2620	0.2620
5	0.2344	0.2344	0.2068	0.2344	0.2068	0.2068	0.2620	0.2620
6	0.2689	0.2758	0.2068	0.2689	0.2068	0.2068	0.2689	0.2689
7	0.2068	0.1931	0.3447	0.1655	0.3103	0.3103	0.4137	0.4137
8	0.2000	0.1931	0.1517	0.1793	0.2137	0.2137	0.2206	0.2206
9	0.1034	0.3172	0.2206	0.2068	0.2068	0.2068	0.2206	0.2206
10	0.2551	0.0827	0.2137	0.2758	0.3103	0.3103	0.4137	0.4137

Table 2: Percentage deviation of vehicles at transport department of KNUST

Vehicle	Average measured tyre pressure (N/mm <sup>2</sup> ) (AMTP)	Average vehicle recommended tyre pressure (N/mm <sup>2</sup> ) (AVMRTP)	Deviation = AMTP - AVMRTP	Percentage deviation (%) ((AMTP-AVMRTP)/AVMRTP)*100
1	0.1793	0.2137	-0.03440	-16
2	0.2103	0.2758	-0.06550	-24
3	0.3068	0.3999	-0.09310	-23
4	0.1551	0.2293	-0.07420	-32
5	0.2275	0.2258	0.00173	0.8
6	0.2551	0.2430	0.01210	5
7	0.2275	0.3620	-0.13450	-37
8	0.1810	0.2172	-0.03620	-17
9	0.2120	0.2137	-0.00173	-0.8
10	0.2068	0.3620	-0.15520	-43

Table 3: Deviation of tyre pressures at KNUST campus

Deviation	Number of vehicles
Above +30%	2
+ (20.01-30) %	1
+ (10.01-20) %	4
+ (0.01-10) %	11
Recommended	2
- (0.01-10) %	9
- (10.01-20) %	30
- (20.01-30) %	29
Below-30 %	12
Total	100

Table 4: Deviation of tyre pressures of the various vehicles at various vehicle stations

Deviation	Kumasi polytechnic			
	campus	Asafo	Roman hill	Kejetia
Above +30%	0	0	0	0
+ (20.01-30) %	0	0	1	0
+ (10.01-20) %	3	5	3	2
+ (0.01-10) %	2	15	12	25
Recommended	0	8	3	10
- (0.01-10) %	5	32	23	71
- (10.01-20) %	23	58	27	72
- (20.01-30) %	21	27	28	59
Below -30%	6	5	3	11
Total	60	150	100	250

100 in Roman Hill and 250 in Kejetia. The same procedure was used for them and the results obtained are presented in Table 4.

Inferring from the Table 3 and 4, only 3.48% (23) out of the 660 vehicles measured had the recommended tyre pressure, indicating that 96.52% (637) of the vehicles deviated from the recommended tyre pressure. This means that majority of the vehicles surveyed deviated from the recommended tyre pressure and this means that most of the vehicles in the Kumasi Metropolis do not use the recommended tyre pressure. The deviation in tyre pressure from the three public stations and the two public institutions therefore

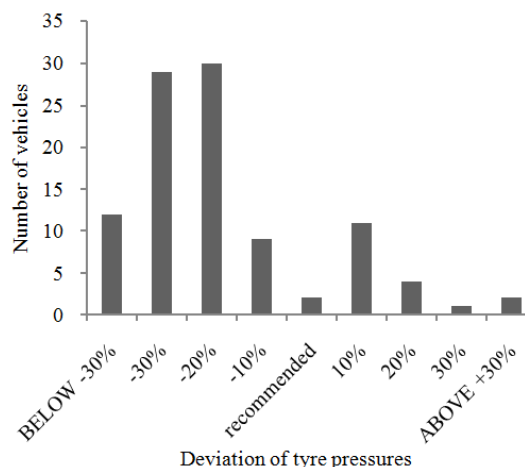


Fig. 1: A graph showing how measured tyre pressures of vehicles on KNUST campus deviate from the manufacturers recommended tyre pressure

necessitated a research into tyre pressure in the Kumasi Metropolis. This is to help in formulating policy recommendations to help avert any negative impact that it can have on motorist and the economy of the country as a whole. Hence, a case study was carried out on KNUST campus on some of the vehicles to ascertain the effect of tyre pressure of vehicles on the fuel consumption.

## RESULTS AND DISCUSSION

**Deviation from recommended tyre pressure:** A field survey was conducted on the KNUST campus to find out whether the various vehicles sampled, that is, 100, for the study had the recommended tyre pressure for

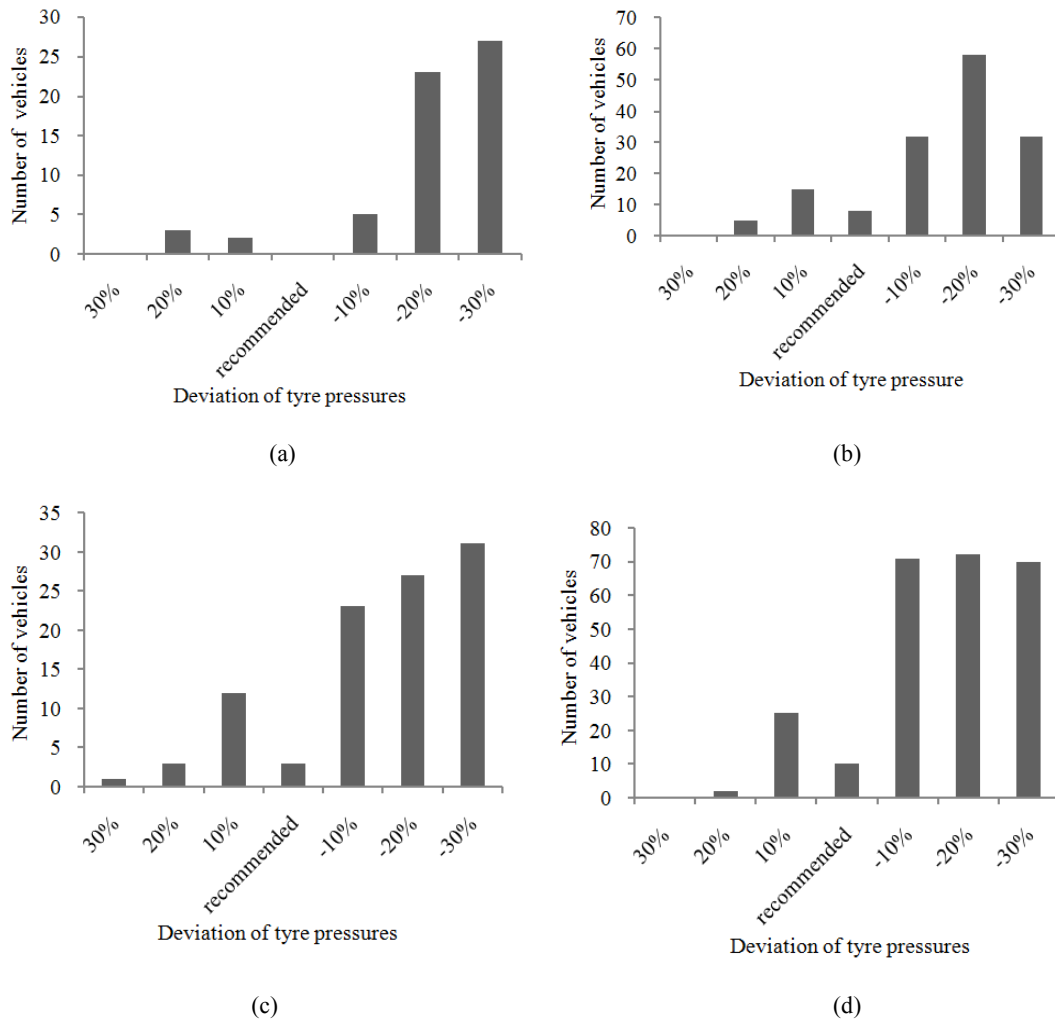


Fig. 2: A graph showing how tyre pressures of vehicles in Kumasi Polytechnic, Asafo, Roman Hill and Kejetia respectively deviate from the manufacturers recommended tyre pressure

smooth running of the vehicles. Tyre pressure gauge was used to measure the tyre pressures of the vehicles. For each vehicle all the tyres were measured. Figure 1 shows how measured tyre pressure of vehicles on KNUST campus deviate from the manufacturers recommended tyre pressure. It could be inferred that almost all 100 vehicles studied deviated from the recommended tyre pressure. Only 2 out of the 100 vehicles studied, representing 2%, conformed to the manufacturer's recommended tyre pressure. The remaining 98 vehicles, representing 98%, deviated from the recommended tyre pressure.

With respect to the above phenomenon, 80% of the deviating vehicles, being the vast majority, fell short of the recommended tyre pressure. Proportionally, 8 vehicles representing 8% were noted to have their tyre pressure being (0.01-10.00) % less than the recommended standard. Thirty vehicles representing thirty (30) percent had their tyre pressures being (10.01-20.00) % less than the recommended tyre pressure, whilst the tyre pressure of 29 vehicles also deviated by

(20.01-30.00) % less than the ideal pressure. The remaining 12 vehicles had their measured tyre pressure more than 30% below the recommended tyre pressure.

On the flip side however, the remaining 18% of the vehicles rather exceeded the manufacturer's recommended tyre pressure. In other words, 11 vehicles had their tyre pressure being (0.01-10.00) % more than the recommended pressure. Four vehicles also had their tyre pressure being (10.01-20.00) % more than the recommended standard, whilst 1 vehicle deviated by thirty (20.01-30.00) % more than the ideal tyre pressure. The remaining 2 vehicles had their measured tyre pressure more than 30% above the recommended tyre pressure.

With this result in view four other stations in the Kumasi Metropolis which are Kumasi Polytechnic campus, Asafo Market station, Roman Hill station and Kejetia station were studied to see how far they have deviated from the manufacturers recommended tyre pressure. Hence the results obtained for the four other stations are presented in Fig. 2.

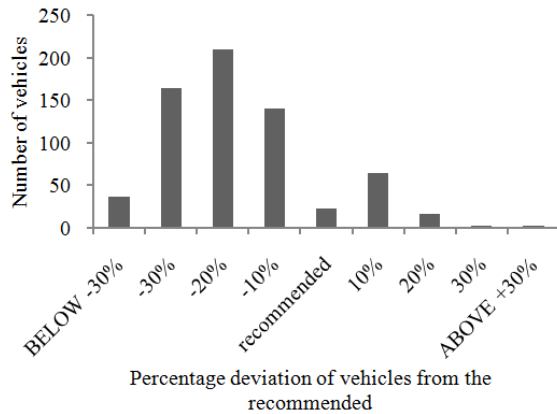


Fig. 3: A graph showing how tyre pressures of vehicles in Kumasi deviate from the manufacturers recommended tyre pressure

From Fig. 2, it could be seen that at Kumasi Polytechnic campus all the vehicles deviated from the recommended tyre pressure. Ninety two percent of the vehicles had their measured tyre pressures below the recommended tyre pressure whilst 8% had their measured tyre pressure above the recommended tyre pressure.

For Asafo, 5% of the vehicles had their measured tyre pressure being the same as the recommended tyre pressure. The rest, which is 95%, of the vehicles had their measured tyre pressure deviate from the recommended tyre pressure. Similar results were recorded at Roman Hill and Kejetia. In Roman Hill, 3% of the vehicles had their measured tyre pressure being the same as the recommended tyre pressure and the rest of the vehicles had their measured tyre pressure deviate from the recommended tyre pressure.

Combining all the five study areas, as shown in Fig. 3, out of the total of 660 vehicles survey in the Kumasi Metropolis, only 23 out of the 660 vehicles representing 3.48%, conformed to the manufacturer's recommended tyre pressure. The remaining 637 vehicles, representing 96.52%, deviated from the recommended tyre pressure.

With respect to the phenomenon below, 83% of the deviating vehicles, being the vast majority, fell short of the recommended tyre pressure. Proportionally, 140 vehicles representing 21% were noted to have their tyre pressure being ten 10% less than the ideal or recommended standard. Two hundred and ten vehicles representing 32% had their tyre pressures being 20% less than the recommended tyre pressure, whilst the tyre pressure of 164 vehicles also deviated by 30% less than the ideal pressure. The remaining 37 vehicles had their measured tyre pressure more than 30% below the recommended tyre pressure.

On the other side however, the remaining 14% of deviating vehicles rather exceeded the manufacturer's recommended tyre pressure. In other words, 65 vehicles

had their tyre pressure being 10% more than the ideal or recommended pressure. Seventeen vehicles also had their tyre pressure being 20% more than the recommended standard, whilst 2 vehicles deviated by 30% more than the ideal tyre pressure. The remaining 2 vehicles had their measured tyre pressure more than 30% above the recommended tyre pressure.

Having carried out an extensive study on the tyre pressure of about 660 vehicles in the Kumasi metropolis it is very alarming to note that only three 3% of the vehicles conformed to the manufactures required tyre pressure. This leaves much to be desired necessitating a study on its effect on vehicle performance.

Emanates from the fact that more energy is now required to move the vehicle and maintain the designated speed it requires. This means more fuel will be required and will therefore increase the cost of fuel since consumption of fuel is very high. Drivers will have to spend much more on fuel expenditure in order to keep their vehicles running smoothly. Therefore, this will reduce the revenue that commercial drivers would have earned from their operations. Some of these costs are also transferred to the general public who patronize these commercial vehicles leading to hikes in the prices of fares, goods and services.

The significant increase in the fuel consumption will be discussed in the next section of this chapter when the performances of five vehicles on KNUST campus are studied. With the increase in fuel consumption, there is a need to get more crude oil in the country. This therefore means government will have to commit more resources to the importation of crude oil in the country. The little hard earned foreign exchange will have to be used in the importation of this commodity. Resources that could be channelled to other vital sectors of the economy come to a standstill hindering the smooth running of the economy. This will therefore affects the developmental agenda of government as well.

From the environmental point of view, as more fuel is burnt it emits more carbon monoxides into the atmosphere causing environmental problems. It is therefore clear that under-inflated tyres do indeed contribute to pollution and its related diseases. With the environmental hazards more resources will therefore have to be invested into health care in order to minimize its effect.

Drivers normally experience a lot of discomfort and inconveniences when the vehicle is underinflated. When a tyre is underinflated, most of the vehicle's weight is concentrated on the tread which is located just under the sidewalls of the tyre, rather than being spread out evenly across the full width of the tyre. This means that as the tyre rolls, the sidewall gets continually flexed (squished, if you will) and heats up. This affects both performance and safety.

Rolling resistance which is caused by deformation of the tyre in contact with the road surface is another

problem that may be brought about as a result of the deviations in the tyre pressures of the vehicles studied. The type of roads that these vehicles ply may also contribute to the increases in the rolling resistance of the tyre to the road inferring that more energy must be applied in order to move the vehicles. This has contributed to the decline and rise of the fuel flow despite increases in the tyre pressure.

Low tyre pressure, excess vehicle weight and high temperatures can cause additional flexing and stress on the sidewalls and can lead to tyre failure. In addition, tyres with low pressure wear more quickly, degrade the vehicle's handling, lower the vehicle's load-carrying ability and increase fuel consumption. In a worst-case scenario, under inflated tyres can lead to a catastrophic blowout or tread separation.

It can be concluded that tyre wear and rolling resistance affect fuel consumption. With the increase in fuel consumption and its effect on socio-economic development there is therefore the need to look at the issue at stake more critically. The facts suggest that a largely unseen and potentially dangerous problem exists for drivers.

### **CONCLUSION**

It could be inferred that 83.49% of the vehicles studied had their measured tyre pressure below the manufacturers recommended tyre pressure. However, only 13.03% of the vehicles have their measured tyre pressure above the recommended tyre pressure. In all, 96.52% of the surveyed vehicles deviated from the recommended tyre pressure.

Every car owner or driver must keenly ensure that their vehicles tyre pressure always conform to the manufacturer's recommended tyre pressure. There should be a massive public education or awareness about this need. This need, according to the research, is against the backdrop that when tyre pressure falls below

the recommended tyre pressure, the decrease in the pressure invariably leads to an increase in fuel consumption. Also underscoring this need is the fact that most drivers or car owners fail to regularly check the level of their tyre pressure.

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