Effect of Using the Nitrogen in Automotive Tires on Vibration and Fuel Consumption

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Abstract. The aim of the research is to investigate the ability of improving the vehicle safety, performance, and reduce operating cost by using nitrogen inflated tires. In this study, three cases were proposed to study the effect of Nitrogen Tires on Car Vibration and Fuel Consumption. The study was conducted according to the three cases; filling the tires with air only, 50% air and 50% nitrogen and nitrogen only. When adding 50% of the nitrogen with the air to the tires, it reduced the vibration velocity to 10% at 60 km/h, 6.6% at 80 km/h and 7.5% at 100 km/h. Also when filling tires with nitrogen, it reduced the vibration velocity to 28.4% at 60 km/h, 23.6% at 80 km/h and 22.7% at 100 km/h. The decrease in fuel consumption for the addition of 50% of the nitrogen was 4.05% while the addition of nitrogen by 100% was 6.1%.

1. Introduction
There has been a considerable measure of enthusiasm for N2 expansion of tires throughout the years. N2 tire swelling is utilized in the aviation and hustling ventures and is starting to make advances into the whole deal trucking industry. A portion of the fundamental advantages of utilizing N2 as a swelling medium seem to be: higher pneumatic stress maintenance because of lower penetrability than O2 through IIR, NR, and SBR mixes (which leads to improved gas mileage); direct volume extension with temperature in light of nitrogen's naturally low water ingestion attributes; and the normal improvement in auxiliary toughness because of a critical decrease in elastic (oxidation brought about via air from the cavity being constrained into the tire corpse). With the approach and commercialization of polymer film detachment strategies, N2 age has turned out to be substantially more reasonable and simpler to keep up than previously. John M. Baldwin paper researched the impact N2 swelling has on the stove maturing execution of traveller tires. Results from field maturing ponders, alongside broiler maturing studies utilizing air and a 50/50 blend of N2/O2 as swelling media, show critical changes in the tire elastic properties with time. At the point when N2 is utilized as the swelling media, the adjustment in elastic properties is essentially backed off or even ended.

Prakash Venkataraman paper investigate the likelihood of utilizing nitrogen expanded tires to improve vehicle security, execution, a diminish working expense. Numerical Pattern was created and improved to foresee the moving opposition of tires recognizing the main reasons affecting on them. Thinking about expanding tires with nitrogen, the weight maintainability of the expansion ga in tires at various by testing the operation conditions. The outcomes showed that the nitrogen increased tires volume lift tire life by about half and the efficiency of vehicle by 23%. by using the results from experimental work and comprehensive computer simulations, it was proved that the filling of tires with nitrogen aid in enhance tire life and vehicle efficiency. J.W. Daws paper creates examples for the basics
nitrogen tires virtue, the swelling weight misfortune ratio, and the development of the nitrogen immaculateness in tire as an element of the gas used to finish up the tire through its life time. A progression of reproductions utilizing the fundamental symbol is created for air and different nitrogen clarities beginning swelling with month to month finish off utilizing air or different nitrogen clarities of. The underlying swelling weight misfortune ratio is appeared as a component of the tire's underlying nitrogen immaculateness. This paper suggests the utilization of the all-out oxygen ignoring through the tire over its life as a measurement for assessment of different swelling plans. This measurement is produced for a few of the mainstream accessible nitrogen swelling purities utilizing both air and nitrogen as a top off gas.

The objective of Miss.P.Y.Mhaske paper was comparing basic stiffness of expansion fluid nitrogen and air to rise up the extent of tire normal force then to enhance stability of the vehicle. Tire Firmness is essential to give agreeable trip to traveller and furthermore avert harm to the working pieces. The firmness of Goodbye Nano vehicle tire having size P135/70R12 in the spiral [or straight] course is estimated. These data depend on the estimation in one tire with expansion weight [1.3, 1.7, 2, 2.4 and 2.7bar] and vertical load run [300 400,500,600,700 and 800kg] for various swelling liquid within walls of tire. Exploratory check of vertical firmness is accomplished for P135/70R12 tire using utilizing load-redirection check led in various swelling weight, expansion liquid and burden with same environments. To plan numerical symbol of un damped spiral mass framework under balanced load. The base straight ability is acquired from hypothetical examination at mentioned burden and weight of various liquid.

Vertical Radial solidness of traveller vehicle tire P135/70R12 is effectively researched utilizing load avoidance strategy with the same environments by utilizing exploratory check outline arrangement. Tire redirection of liquid Nitrogen is below contrast with Air for all weights. The extension weight legitimately impacts the firmness of tire as expansion weight increment, solidness of tire likewise increments. From hypothetical investigation, the base vertical sufficiency is acquired at shown burden and weight condition for a liquid Nitrogen contrast with Air. That shows least hindrance is transmitted to the skeleton and the traveller of the vehicle.

Using three different expansion fluids Argon, Air and Nitrogen In Mayuresh Mutha paper Vertical radial stiffness for Ceat 90/100R10 tire was studied. Tire firmness assumes a significant job in car ride solace, security and lessening vibrations. The firmness also estimated utilizing Deflection force strategy with various expansion weights, swelling liquid and continuously expanding burden in static condition. The firmness was breaking down at swelling weight [24, 26, 28, 30, 32, 34 psi] and burden extend [20, 40, 60, 80, 100, 120, 130, 140, 150 kg] for various expansion liquid filled in the tire. The outcomes demonstrate that Vertical Radial solidness of Ceat 90/100R10 tire is researched utilizing load redirection technique when the tire is under static burden condition. Redistribution of liquid Nitrogen when contrasted with Air for all burdens and for Argon is greatest. As the swelling weight builds, the solidness of the tire additionally increments in every one of the three cases. Solidness of tire loaded up with Air is observed to be most extreme pursued by the firmness of Nitrogen and afterward Argon filled tire.

Nader Jalili, Ph.D study two projects on nitrogen inflated tires, The moving obstruction of swelled tires is a significant segment of protection from vehicle movement and adds to the all-out burden and fuel utilization. Along these lines, many studies have been centred around the way that different tire variables (e.g.expansion weight (P), load (L), and speed (V) influence moving obstruction with the goal that efficiency can be expanded. Ongoing exploration discoveries show that filling tire with nitrogen can keep up legitimate expansion and reduction the disintegration of the elastic.

Walter H. Waddell study prove that Nitrogen molecules are four times larger than air and as a result will not seep through the casing of the tyre like air, which would normally result in pressure loss. Nitrogen is likewise a steadier gas than air and accordingly won't give high variances in temperature and in this way weight inside the tire.

Jumaa S. Chiad and Fadhel Abbas Abdulla study discusses experimentally the impact of number and area of the dampers in the suspension framework on the vibration relocation at revolution speed (1000, 1200, and1400 RPM). It has been discovered that the expanding number of dampers balances out the
clothes washer by an exceptionally little rate which is practically unimportant conversely; expanding will build the cost as it were.

2. Experimental Work
The main components of the study are the car type is (KIA SPORTAGE 2017) shown in the figure1, and vibration meter device with the vibration sensor stabilization sites. It was ascertained the level of height of the four wheels by measuring the height of the centre of the wheel until the surface of the ground, as shown in the figure 1. The vibration sensor was stabilized on dashboard and the installation was in the middle as shown in the figure 2. The parts used in the experiment will be described in detail as follows:

![Figure 1. The car type is (KIA SPORTAGE 2017)](image1)

![Figure 2. Measuring the height of the centre of the wheel.](image2)

2.1. KIA SPORTAGE 2017. The car type is (KIA SPORTAGE 2017) Drivetrain Front-wheel drive, Engine Name 2.4L L4 DOHC 16-valve with fuel tank capacity 62 L, Gross Vehicle Weight 2085 kg, Height 1635 mm, Length 4480 mm, Width 1856 mm, Anti-Lock Brakes 4-wheel ABS and Wheel Type 17-inch alloy wheels.

The study was conducted according to the following cases:
Case 1: Filling the tires with air only.
Case 2: Filling of tires by 50% air and 50% nitrogen.
Case 3: Filling tires with nitrogen only.

2.2. Vibration Meter – Lutron VB-8201HA. Steps of Measurement: Vibration Meter which used to measure Velocity and Acceleration. This is done by installing the accelerometer (Vibration sensors) on the dashboard when driving a car at 60, 80 and 100 km/h, vibration meter device Shown in Figure 3 and Figure 4 is shown the Installation site of sensor on the dashboard.
2.3. **Nitrogen Air Filling Machine.** The nitrogen filling device used is shown in Figure 5.

![Nitrogen Air Filling Machine](image)

**Figure 5.** Nitrogen Air Filling Machine
3. Results and Discussion

It is clear that the values of the vibration velocity resulting from tire-filled change (air and nitrogen) vary from case to case. We note the different vibration velocity in each case in Table 1.

| speed  | Nitrogen | Air & Nitrogen |
|--------|----------|----------------|
| at 60 km/h | 28.4%    | 10%            |
| at 80 km/h | 23.6%    | 6.6%           |
| at 100 km/h | 22.7%    | 7.5%           |

3.1. Case (1) Filling the tires with air only. In this case, the relation of the vibration velocity with the time was calculated by the vibration meter when driving the car at a different speed 60, 80 and 100 km/h. In this case the maximum vibration velocity of 88.6 mm /s when driving a car at speed 100 km/h. As shown in Figure 6.

![Figure 6](image)

**Figure 6.** First Case of Vibration velocity Versus Time at Different Speed 60, 80 and 100 km/h with filling the tires with air only.

3.2. Case (2): Filling of tires by 50% air and 50% nitrogen. In this case the maximum vibration velocity of 85 mm /s when driving a car at speed 100 km/h. As shown in Figure 7.
3.3. Case (3) Filling tires with nitrogen only. In this case the maximum vibration velocity of 72 mm/s when driving a car at speed 100 km/h. As shown in Figure 8.

3.4. Fuel Consumption. Fuel Consumption as shown in the blue track on the map for distance 100 km at a constant speed and for the cases studied. As in Figure 9.
Figure 9. distance 100 km at a constant speed and for the cases studied.

The decrease in fuel consumption for the addition of 50% of the nitrogen was 4.05% while the addition of nitrogen by 100% was 6.1%.

- **Fuel consumption in the distance travelled**
1- (9.96) L in a state filled with tires (Nitrogen).
2- (10.18) L in a state filled with tires (Air with Nitrogen).
3- (10.61) L in a state filled with tires (Air only). As in Figure 10.
4. Conclusion
In this study, three cases were proposed to study the effect of Nitrogen Tires on Car Vibration and Fuel Consumption. Following conclusions are drawn from the present study:

1 - Readings of the vibration meter It was noted that the vibration velocity when filling tires with nitrogen was up to 30 mm/s, when driving a car at speed 60 Km/h, 36.7 mm/s at the speed of 80 Km/h and 35.9 mm/s at speed 100 Km/h.

2 - The highest value of vibration velocity was recorded in filling the tires with air only, where the maximum vibration velocity of 86.6 mm /s when driving a car at speed 100 km/h.

3 - When adding 50% of the nitrogen with the air to the tires, it reduced the vibration velocity to 16% at 60 km/h, 7.4% at 80 km/h and 18.6% at 100 km/h.

4- when filling tires with nitrogen, it reduced the vibration velocity to 42.2% at 60 km/h, 26.4% at 80 km/h and 30.2% at 100 km/h.

5- Low fuel consumption due to a decrease in vibration speed in a state filled with nitrogen tires.

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Figure 10. Fuel consumption in the distance travelled by litre (L).
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