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THE EFFECT OF USE OF AIR CONDITIONER ON ENGINE VIBRATION IN GASOLINE CAR ENGINES

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Abstract

Air conditioning in automobiles is done by air conditioning compressor driven by the engine. The engine exerts a specific power to run air conditioning system. During running, fuel consumption, noise and vibration increase. Most of gasoline automobiles in Turkey have used Liquefied Petroleum Gas (LPG) as an alternative fuel. In this study, the effect of use of Air Conditioner (AC) on engine vibration in gasoline car engines are experimentally investigated. According to the experiment results, it is observed that the use of AC while running on LPG decreases the engine vibration at the revolution speeds of 800, 2000, 3000 and 5000 rev/min whereas the use of AC while running on gasoline decreases the engine vibration at the revolution speeds of 2000, 3000 and 4000 rev/min. In addition to that, when the AC is on, the levels of vibration increase in the engine while running on LPG and gasoline are observed to be linear and nonlinear with the increase in the idle revolution speeds, respectively. Accordingly, it can be concluded that the car engine while using LPG is running more stably compared to that while using gasoline.

Key words: *Car engine, vibration, AC, gasoline, stability*

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1. Introduction

People are exposed to mechanical vibrations during their trips generating from various reasons. In recent years, many research have been done aiming to handle this challenging situation. According to Rakheja and Sankar's research [1]; people who are working with trucks, tractors and other land vehicles in the rough terrain situations has often encountered both physical health problems and psychological disorders because of the effect of vehicle vibrations [1]. This situation can be considered to be the same in automobiles. It is extremely important to compensate these problems in consideration of ergonomics. Ergonomics also deals with the studies of designing working areas and equipment to diminish vehicle vibrations for the human health, safety and comfort [2]. There are two main sources of shocks and vibrations in vehicles. The first one is internal sources while the second one is external sources. Internal sources causing vibration in vehicles are generally engine, power transmission systems (gearshift, disc clutch, differential mechanism) and tire mechanism [3]. Vibration and noise are two important factors that affect security and comfort of a vehicle. Engine vehicles having a rather complex dynamic system are continuously interacting with passengers, loads, road ground, and air flowing outside the vehicle. Main sources of vibration and noise in road vehicles are internal combustion engine, road surface and aerodynamic effects. The symptoms of attention deficit, stress, being nervous and tiredness are observed in people who are continuously exposed to vibration and noise [4-5]. So a driver in this situation has higher possibility of having an accident. Also the vibrations in the vehicle cause impact problems, fatigue, frictions and thermal stress of the associated components; hence, causes breakdown of the engine or its crucial components. The breakdown situation stemming from the material fatigue is one of the most important results of the vibration [6, 8]. Vehicle engine manufacturers aim to develop engine having less volume, being more stronger, and having lower fuel consumption in order to be able to take place in the current competitive market. However tremendous improvements have been emerged, consumers' expectations of more comfortable and secure vehicle lead researchers to investigate how to decrease the vibration and noise level of the vehicles [7-10]. Although vibration and noise seems to be two separate problems, they are closely associated with each other. Major source of noise is known to be vibration. It was found that decreasing of vibration level reduces noise quantity approximately two times [11].

The forces arising from the piston-rod-crank mechanism and combustion are the biggest forces to cause vibrations in engine. In the literature, several mathematical models taking into consideration these two types of forces are put forward giving relationships between the forces and the vibrations occurred at this time [9-12,13,14]. On the other hand, in addition to the forces, the effect of AC on the engine vibration for an internal combustion engine using Liquefied Petroleum Gas (LPG) fuel as an alternative fuel should be investigated to address the stability of the engine operation under these alternative fuel conditions. To that end, in this work, an experiment for internal combustion gasoline engine using LPG which belongs to Ford Mondeo, is carried out under the two conditions of the AC (when it is active and inactive).

2. Material and Methods

The internal combustion engine used in this experiment is 1596 cc 125 HP engine using LPG belonging to Ford Mondeo. The experiment was conducted after making all required maintenance of the car. Also, the experiments were made at the nominal operating temperature of the engine.

For measurement of the engine vibrations (as the acceleration of gravity (g)), an accelerometer which have an integrated triaxle (X, Y, Z axes) acceleration sensor with the accuracy of ±0.5 and the measurement range of ±18 g, and a personal computer including interface software to store the measured vibration data were used. The experiment equipment are given in *Figure 1.* Vibration data were taken under record via computer. The vibration data was recorded automatically in a time of 500 ms by the software. The measuring period for each chosen engine revolution speeds (800, 2000, 3000, 4000 and 5000 rev/min) was accepted as 15 sec. At the end of each measurement, the average and maximum resultant acceleration values were recorded.

Fig. 1. The experiments equipment: the gasoline engine using LPG (a) and the accelerometer (b)

3. Results and Discussion

The maximum vibration values while running on gasoline at the situations of AC on and off are presented in Figure 2. Herein as an example for the critical points, the vibration value at 800 rev/min was measured to be nearly 4.68g when AC is on whereas it was measured to be 5.32 g when AC was off. This situation is similar to those at the revolutions of 4000 and 5000 rev/min. On the other hand, an increase in the maximum vibration values was observed at the revolutions of 2000 and 3000 rev/min when AC was on.

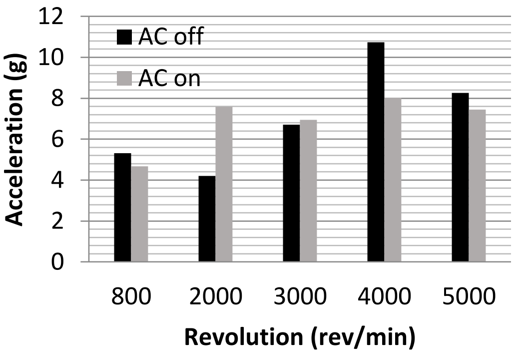

Fig. 2. Maximum vibration values while running on gasoline.

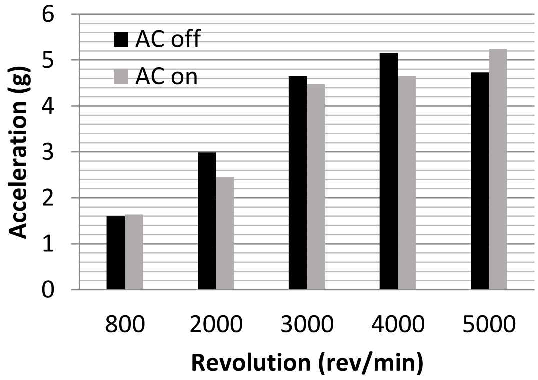

Fig. 3. Average vibration values while running on gasoline.

The average vibration values while running on gasoline at the situations of AC on and off are presented in Figure 3. As can been in the figure, the vibration values increased at the revolutions of 2000, 3000 and 4000 rev/min when AC was off. On the other hand, an increase in the average vibration values was observed at the revolutions of 800 and 5000 rev/min when AC was on.

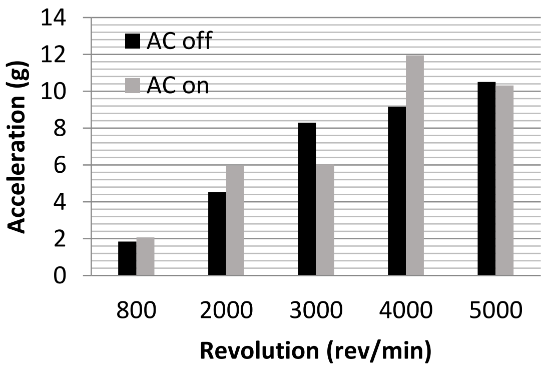

Fig. 4. Maximum vibration values while running on LPG.

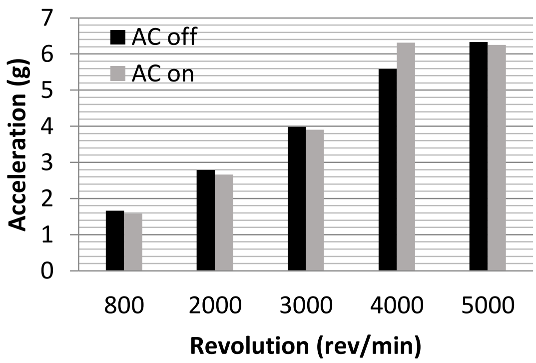

Fig. 5. Average vibration values while running on LPG.

The maximum vibration values while running on LPG at the situations of AC on and off are presented in Figure 4. As can been in the figure, the vibration values increased at the revolutions of 3000 and 5000 rev/min when AC was off. On the other hand, an increase in the average vibration values was observed at the revolutions of 800, 2000 and 4000 rev/min when AC was on.

The average vibration values while running on LPG at the situations of AC on and off are presented in Figure 5. As can been in the figure, the vibration values increased at the revolutions of 800, 2000, 3000 and 5000 rev/min when AC was off. On the other hand, an increase in the average vibration value was observed only at the revolution of 4000 rev/min when AC was on.

From these results, the average vibration values obtained at the use of both two fuel types (gasoline and LPG) can be considered to be more reasonable indicators for the stability of the engine operation, compared to the maximum vibration values obtained.

4. Conclusion

In this work, the effect of AC on the engine vibration for an internal combustion engine using Liquefied Petroleum Gas (LPG) fuel was investigated to address the stability of the engine operation. For this purpose, the maximum and average vibration values of the engine were measured at different idle revolution speeds during a period of 15 seconds. From the results of this experiment, the average vibration values obtained at the use of both two fuel types (gasoline and LPG) can be considered to be more reasonable indicators for the stability of the engine operation, compared to the maximum vibration values obtained. Furthermore, when the AC was on, the levels of vibration increase in the engine while running on LPG and gasoline were observed to be linear and nonlinear with the increase in the idle revolution speeds, respectively. Accordingly, it can be concluded that the car engine while using LPG is running more stably compared to that while using gasoline. In the future works, the vibration variations of the engine using LPG can be investigated at different environmental temperatures.

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