Experimental Investigation of Noise Pollution Level Emerged From the Most Common Use Car in Saudi Arabia.

Khaled S. AlQdah*

Taibah University, Faculty of Engineering, Mechanical Engineering Department, AlMadinah AlMunawwarah 42353, Kingdom of Saudi Arabia

Abstract

The present study documents noise pollution levels measured for the most common cars used by people in Saudi Arabia. The noise levels were measured following standard procedure by using calibrated sound pressure level meter at all sides of the car front, rear, right and left sides. This investigation has been conducted to measure the noise pollution level from Toyota car Model 2002 because it used for most Saudi people. Measurements of the noise level from this car at stationary and motion situation have been carried out. The noise levels produced by variable engine speed ranged from 750 to 4000 rpm were recorded. The sound level found to be 59.45 dBA when the vehicle in motion at normal speed. When the vehicle at idle speed 750 rpm the maximum noise level measured at the back exhaust 50.4 dBA where the minimum level recorded at the right side 40.8dBA. When the car parked or at stationary state and the engine at 2500 rpm the maximum noise level at the back exhaust is 53dB A whereas the minimum level showed from the left side. For maximum engine speed 4000 rpm the back exhaust area has a maximum noise level 58.2 dBA where as the right side at 51.2 dBA. The maximum sound level recorded near the engine at speed of 4000 rpm was 57 dBA but the minimum level recorded at 1000 rpm. From the recorded results it can be seen these measured noise level are under the acceptable ranges due to the progress and development of vehicles emission reduction and the environment protection issues. Based on the study findings it can be inferred that there is an urgent need to set up noise standards in the country to control the noise pollution level from vehicles as well as to keep clean environment.

© 2013 The Authors. Published by Elsevier Ltd. Open access under CC BY-NC-ND license. Selection and/or peer-review under responsibility of the TerraGreen Academy

Keywords: Noise Level; Pollution; Traffic Noise; Emission; Environment.

* Corresponding author. Tel.: 00966 568557421; fax: 00966 48475837. E-mail address: dr.khaled_qdah@yahoo.com; kqdah@taibahu.edu.sa.
1. Introduction

Environmental action in Saudi Arabia encounters numerous challenges that made it imperative to apply traditional and non-traditional techniques to bridge the gap between the quality of life. Saudi citizens aspire to and that which they really get as a result of ongoing pressures affecting their environment. Harmful emissions into the air represent an environmental pressure that reflects negatively on man's health and productivity; thus leading to a real loss in the national economy. The multiple sources of air pollution and the heavy load of pollutants are but a normal consequence of accelerated economic growth Saudi Arabia witnessed over the past three decades. Higher rates of air pollution are becoming strongly correlated with economic progress. Therefore, the Kingdom has paid special attention to monitoring and reducing such emissions through concerted efforts under taken at both national and international levels a like [1].

Saudi's climate is an important factor in increasing the pressure of air pollution; Vehicles are the major source of air pollution. Almost two thirds of carbon monoxide and 50% of hydrocarbons and nitrogen oxides that pollute the air are attributed to fuel combustion, also industrial zones and widespread small industries within the populous mass. At the time, large number of studies on the standards adopted and the acceptable level of noise in the vehicle have been conducted but the very small number of these studies focused on noise around the car traveling at a certain speed or the engine spins at a constant speed and when the car parked, the most available studies for the traffic noise level and vehicles noise level are: [2] Al-Ghonamy, 2009, conducted a survey of the traffic noise pollution in al-Khobar city. The main objective of his study was to evaluate traffic noise pollution in the kingdom of Saudi Arabia (KSA) cities. The results indicate that traffic noise levels in al-Khobar are higher than those recommended by noise standards for the day, afternoon and evening periods residential and commercial areas.[3] Gündoğdu, etal 2005, the effect of traffic composition on the noise pollution has been investigated in a small city Erzurum, located in eastern Turkey, where the population is about 400,000. Manual noise measurements and vehicle counts were performed at the four heaviest traffic points in the city for a period of 12 h. using the information on vehicle composition and the maximum legal noise emissions of each type of vehicles. [4] Rahmani, etal, 2011, two models for predicting in-city road-traffic noise pollution of Mashhad has been obtained. Traffic volume, composition, and speed have been chosen as model's parameters. Vehicles were classified into light cars and medium and heavy trucks. Reference emission level of each group was determined experimentally based on perpendicular propagation from central lane of traffic road. [5] Al-Ghonamy, 2010, evaluation of road traffic noise in the city of Al-Dammam using digital sound level meter with frequency weighting networks. All measurements in this study were exceeding the permissible environmental standards used in kingdom of Saudi. This indicates that all locations investigated are exposed to high noise levels mainly caused by road traffic. [6] Hammad and Abdelazeez, 1987, studied the traffic noise and related annoyance in the city of Amman. They showed that the national vehicle registration jumped from 310,000 to 575,000 which represent an average annual increase of about 11%. This is somewhat comparable to the percentages reported for many of the European and Asian countries. Supplementary col 2 3 4 5I am the caption[7] Waters, 1974, a survey of the characteristics of the noise emitted by commercial vehicles has been made. [8] Suresh etal, 2009, examines the effect of traffic, vehicle and road characteristics on vehicular emissions and reviewed the traffic flow and emission models. [9] King et al, 2011, AcknowledgmentsReferences quantified the effect of the impact on noise levels of a ban on private cars in Dublin city centre.[10] Serkan et al, 2009, carried out a study to determine motorway noise levels in Tokat city centre, located at the northern part of Turkey.
The overall objective of this work is to investigate the exterior noise level from one of the most common used car by the Saudi Arabia people and acceptable for the majority of the people Toyota, model 2002. Comparison of the noise level for this car with the standards will be conducted as well as recommendations to reduce the noise pollution level will be proposed. Therefore significantly reduce Saudis’ exposure to noise, particularly in urban areas and to examine how noise is perceived by Toyota car affect the people live.

2. Method and Material
The noise levels were measured with the help of a portable precision digital sound level meter (BK Model- type 2235) shown in figure 1. This instrument is primarily designed for community noise surveys. A large digital display gives single value as an indication of the maximum ‘A’ weighted RMS (root mean square) sound pressure level measured during the previous second.

![Figure 1. Standard Portable digital sound level meter used in this investigation](image-url)

Standard method to measure the noise level of the car at stationary or in motion was used. A microphone is mounted 1.2 m above ground and 7.5 m from the center of the test road for the vehicle in motion (Toyota, model 2002). Exterior noise level round the car from all sides measured at the position of 1 meter from the car body at different angles and location front, back, right side left side, exhaust and near the engine at 1.2 m above the ground. Two persons needed to measure the noise level, one who monitors the noise level and the other to control the engine speed at the desired ranges. In order to get accurate and acceptable results and to avoid any other surrounding noise sources, test was conducted in the yard of free and
far from any other sources of noise, such as heavy traffic areas, factories and residential areas and high-rise buildings. Also, to avoid noise caused by wind, rain and other weather conditions, very quiet and calm day has been selected to conduct this test. The noise level can be considered as a combined from exterior and tires as well as exhaust and engine. All of these contributed in the traffic noise pollution level in addition to a large number of different vehicles like buses, trucks, motors and other transportation facilities.

4. Results and Discussion
Evaluation of noise measurement was based on limited or acceptable values reported in table 1 for noise control regulation and international standards [11]. The exterior noise control work is mainly motivated by legislation demands while interior noise and vibration control work is motivated by driver and passenger noise and vibration comfort requirements. The main car noise are found to be from engine structure noise, transmission noise, exhaust noise, tire noise, fan noise, air intake noise.

Table 1. International standards exterior vehicle sound levels in vehicles

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Sound level dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal car</td>
<td>74</td>
</tr>
<tr>
<td>Bus and truck with total weight below 3.5 ton with total</td>
<td>76</td>
</tr>
<tr>
<td>weight below 2 ton</td>
<td></td>
</tr>
<tr>
<td>with total weight above 2 ton but below 3.5 ton</td>
<td>77</td>
</tr>
<tr>
<td>Bus with total weight above 3.5 ton with engine power</td>
<td>74</td>
</tr>
<tr>
<td>below 150 kW</td>
<td></td>
</tr>
<tr>
<td>with engine power 150 kW or above</td>
<td>80</td>
</tr>
<tr>
<td>truck with total weight above 3.5 ton with engine power</td>
<td>77</td>
</tr>
<tr>
<td>below 75 kW</td>
<td></td>
</tr>
<tr>
<td>with engine power below between 75 kW and 150 kW</td>
<td>78</td>
</tr>
<tr>
<td>with engine power above 150 kW</td>
<td>80</td>
</tr>
</tbody>
</table>

Figure 2 shows the sound level of the car at various point around it when this car was parked but the engine worked at an idle speed of 750, 2500 and 4000 rpm respectively. From this figure it can be seen that the back exhaust area witness the maximum noise level of 50.4 db where as the right side has 40.8 dBA at idle speed 750 rpm which is acceptable and at normal ranges. The maximum noise level recorded at the engine speed of 4000 rpm near the exhaust zone 58.2dBA where the minimum value at the left rear. The higher noise levels were recorded at the exhaust zone because the exhaust and intake system noise originates from the pressure pulsations caused by the operation of the engine and additional flow generated noise forms the major. To control the noise generation at the source involves making changes to the combustion process typical sound absorbing materials used are rock wool, glass wool and plastic foams.
Figure 2. Noise levels measured at variable engine speed at different locations round the car

The reported data were plotted in the noise level field round the car shown in figure 3 at an engine speed of 2500rpm where the maximum acceptable value 70dBA. From this noise level field it can be seen that the measured values which are highlighted in red colour fall below the acceptable limits which is a good indication that this model of vehicles was controlled from the environment point of view and its emissions is less than allowable values. Higher values were recorded at front or near the engine but the lower value for the left side of the car. Also the exhaust area in the left back of the car seemed to be at higher noise level. From this figure it can be concluded that this model which is preferred from the most and common people is save to be used when noise level is important.
Figur3. Noise field of vehicle at stationary position at 2500 rpm

Figur4. Noise field of vehicle at stationary position at 4000 rpm
Figure 4 represents the noise level field at engine speed 4000 rpm. From this figure it can concluded that the noise level varies directly with engine speed but the measured values also less than the acceptable limits. These acceptable and satisfied measured values can attributed as a results of modifications and development and technology that the vehicles industries have witnessed last decade and environmental concerns to reduce traffic noise pollution levels and its bad impact on both human and environment. In general, trucks are typically noisiest followed by buses and motorcycles while cars are the quietest. The contribution of cars to the overall traffic noise level is however great because of their large numbers (about 80% of the road traffic).

For higher speeds, above 70 km/h, tire-road noise dominates the car exterior noise generation.

Figure 5 indicates the noise level measurement for the car at variable engine speed near the engine. Maximum noise level was recorded at 4000rpm under normal operating conditions near the intake system 57dBA which is below the accepted limits or standards. It can be seen that the sound output level of the car (Toyota) that have been checked and found within the international standards 60dBA. The Experimental work shows that the most powerful affect upon the sound level is made by the frequency of the crankshaft rotation. The sound level increases about 2 dBA with the increasing of crankshaft rotation upon each 1000 PPM.

![Figure 5. Engine noise level measured at variable engine speed](image)

The outer noise from the car was found to be 59.45dBA and it is within the standards of exterior vehicle sound levels. For lower speeds below 40-50 km/h, engine noise including exhaust and intake noise dominates for passenger vehicles (cars) and the most noise emitted from 0 to 0.6 m above roadway, primarily from tire-roadway interface. Structures, topography, ground cover, and weather conditions such as wind, temperature and relative humidity.

During this survey the following findings were monitored, all imported cars do not obtain certificates of car noise, and there is no strict legislation to prevent imports of cars that exceed the noise level limit, and there is of awareness towards the impact of traffic noise impact on the human life and environment.
5. Conclusions
This study has provided a thorough descriptive look at noise levels emerged from the common use car in Saudi Arabia. The measurements were performed for Toyota model 2002.

The outer noise of the car under consideration was 59.45.dBA when the vehicle in motion at approximated speed of 40- 50 km/hr which the general speed inside the cities and this value within the standards of exterior vehicle sound levels. The obtained results shows that at an idle speed 750 rpm the maximum noise level is 50.4dBA at the exhaust zone and this value increased as the engine speed increased. Measurements were performed near the engine with 57dBA at engine speed of 4000 rpm. It can be notice that from the analysis of noise filed for Toyota car there is an irregularity of about in noise levels, the reason for that is the major power of sound emission comes from exhaust and engine location and the method of installation.

It can be seen that the most powerful affect upon the sound level is made by the frequency of the crankshaft rotation. The sound level increases about 2dBA with the increase of crankshaft rotation upon each 1000 RPM. It is high time that the concerned authorities should wake-up to

Noise measurement which is an important diagnostic tool in noise control technology. It was necessary to establish national noise level standard specifications for imported cars.

References
