Noise analysis in Malaysian passenger car cabin

M.A. Abdullah[1,2,*], J.F. Jamil[1,], N. Basrah[1], A. Putra[1,2], M.A. Salim[1,2]

[1)] Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.
[2)] Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

*Corresponding e-mail: mohdazman@utem.edu.my

Keywords: Noise analysis; noise distribution; passenger comfort; vehicle cabin noise.

ABSTRACT - In this paper, experimental study on noise analysis in cabin of a 1.3 cc passenger car is performed. The noise is recorded using sound level meter at 3 different places, namely, at the hand brake, near the drivers' pedals and at the bottom of front passengers' seat. The experimental study is performed at different engine speeds at static and dynamic conditions with and without air conditioner switched on. The data is analyzed and discussed for comparison. The noise distribution in the passenger cabin is generated at 3 locations. From the results, it is shown that, different locations give different density of noise. The passengers' noise comfort level is still achieved with and without air conditioning.

1. INTRODUCTION

There are many sources of noise in passenger car cabin. In previous studies, in order to provide passenger comfort, researchers tried to reduce the noise either by; trouble shooting the source or improving the sound barrier by applying sound absorber. The noise is coming from engine and powertrain, tire, wind and air conditioning system. The road and tire interaction is generally providing low frequency noise depending on speed, road surface and tire configuration. The engine in the powertrain system creates noise even at idle engine operation due to vibration of the components and parts [1]. The noise from wind is affecting the cabin due to aerodynamic surface, speed and sometimes by the side mirror and windows' visors [2]. The air conditioning system however, is always neglected due to the necessity for the passenger comfort inside the cabin.

In this research, noise experimental analysis is performed on a Malaysian passenger car cabin. The data is studied and analyzed at different positions and vehicle conditions. This study is carried out to measure the noise inside the car cabin and justified whether the noise is acceptable for the passenger.

2. METHODOLOGY

A 1.3 cc Malaysian passenger car is used in this experiment. The engine speed is set from 1000 to 3000 rpm at static and dynamics conditions. During dynamic testing, the car is operated at speed from 80 to 120 km/h. The route for dynamic test is shown by Figure 1. RION Sound Level Meter is used in this experiment (Figure 2).

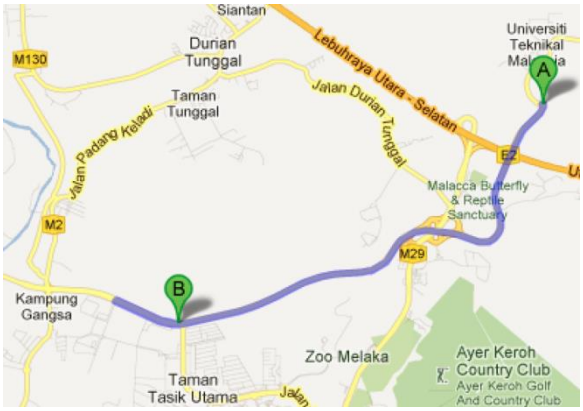

Figure 1 Dynamic test route

Figure 2 Sound level meter

3. RESULTS AND DISCUSSION

The passenger comfort level for noise is around 40 to 50 dB at frequency from 2.5k to 3k Hz [4][5]. Based on this fact, the results of the noise analysis are focused at frequency from 2 to 4 kHz. Figure 3, 4 and 5 show the noise data for 2 kHz, 4 kHz and at 3000 rpm engine speed.

From Figure 3 and 4, it can be observed that the speed of the car affects the noise inside the cabin. The noise inside the cabin is increased as the speed increased. This is due to the fact that as the engine turns faster to provide power for the car to increase speed, more vibration is generated internally. As the speed increased, more interaction between tire and road is happened. These vibrations and interactions cause the

© Centre for Advanced Research on Energy

increment of noise inside the cabin of the car. The different between air conditioning systems switched on and off is only about 1 dB.

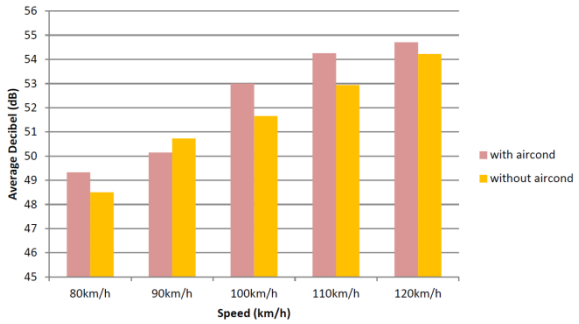

Figure 3 Noise data at 2 kHz

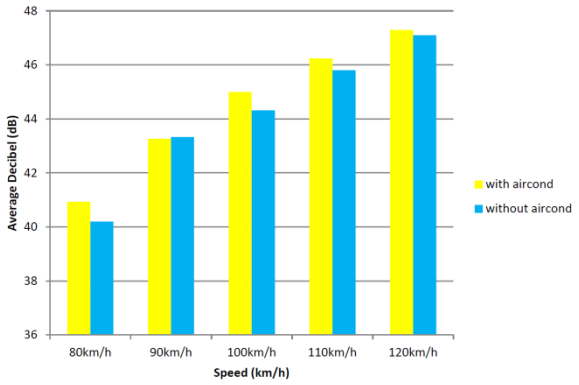

Figure 4 Noise data at 4 kHz

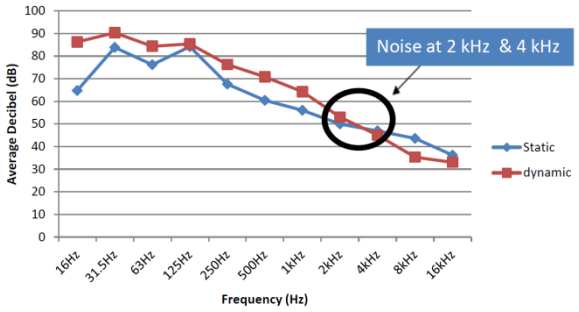

Figure 5 Noise data at 3000 rpm engine speed

4. CONCLUSIONS

The noise inside the cabin of a car is caused by several reasons. The noise is also affected by the speed of the car. For the comfort of passengers, 1 dB different in noise for the car with and without air conditioning system switched on is acceptable. Since human ears can accept noise as high as 50 dB for comfort level and hear 2 to 3 kHz of frequency, the noise generated inside the cabin for all experiments are considered as comfort.

5. ACKNOWLEDGEMENT

The authors gratefully acknowledged the Advanced Vehicle Technology (AcTiVe) research group of Centre for Advanced Research on Energy (CARe), the financial support from Universiti Teknikal Malaysia Melaka and The ministry of Education, Malaysia under Short Term Research Grant, Grant no. PJP/2014/FKM(10A)/S01330 and Fundamental Research Grant Scheme (FRGS), grant no.: FRGS/2013/FKM/TK06/02/2/F00165.

6. REFERENCES

[1] A. Putra, F.A. Munir and C.D. Juis, “On a simple technique to measure the airborne noise in a car interior using substitution source”, Int. Journal of Vehicle Noise and Vibration, Inderscience Publishers, Vol. 8, No. 3, 275-287. 2012.

[2] A. Putra, A.Y. Ismail and M.R. Ayob, “Employing the micro-perforated panel in the vehicle cabin: Is this possible?”. Malaysian Technical Universities International Conference on Engineering & Technology (MUiCET 2011), 674-679, 2011.

[3] Government of South Australia, “Noise in the workplace: what you should know”. SafeWork SA, Last accessed 02/01/2015, Address: http://www.safework.sa.gov.au/uploaded_files/Noise.pdf, 2015.

[4] Noise Help, “Noise dose chart: noise exposure limits”. Noise Help, Last accessed 02/01/2015, Address: http://www.noisehelp.com/noise-dose.html, 2015.