EXPERIMENTAL EFFECT OF NOISE AND BACKPRESSURE OF A (BAJAJ) TRICYCLIC EXHAUST SYSTEM

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ABSTRACT

The exhaust system being a critical system of any automotive vehicle plays a responsible role of improving the ride comfort of the tricyclic motor by attenuating the noise from the engine without deteriorating the engine performance. Due to exhaust noise reduction and the effect of backpressure as it affect the engine performance and invariably increase fuel consumption, there is need to examine the effect of backpressure and the sound level of a 3 wheel tricycle motor (BAJAJ) model to ascertain the level of noise and exhaust pressure that goes out through the muffler. Since tricycle are relatively new as compare to the other forms of public township transportation, the study of this exhaust characteristics and the profile of the flow through the complete exhaust is desirable. The main aim of this research is to conduct an experimental and computational fluid analysis of the effect of noise and backpressure of a tricyclic motor. In order to carry out the experiment, a tricyclic motor, triangular stand, liquid crystal display unit, personal computer, a wind sensor, temperature and pressure sensor, velocity, and sound sensors linked in a multi-channel system via a universal serial bus were used. The silencer geometry was modeled and flow simulation analysis of the exhaust system was analysed. The results of loading and unloading for backpressure 101483.5 bar and 982.97 bar respectively. The noise recorded was 78dB (A), which was more than the recommended sound level for urban night period.

Keywords: **Bajaj, Backpressure, Exhaust, Noise, Tricycle,**

Introduction

A three-wheeled motorcycle which is also referred as a motor tricycle is designed with either a single front wheel and two rear wheels, or two front wheels and a single rear wheel.

Tricycles are a popular mode of public transportation among commuters due to their high accessibility, availability, affordability, and convenience. This type of transport is much less expensive in fares than another mode of road transport such as bikes and taxis, thus they play an important role in today Nigeria's overall transportation system. Tricycles are the most convenient transportation in most of the cities and usually are located both in big and smaller roads (Kumar et.al, 2016). Moreover, despite the need to popularize the tricycles over other means of road transport in Nigeria, which are characterized by fatal crashes and other forms of vulnerabilities, these three wheel vehicle poses environmental and social challenges such as fine particles emission, noise, and temperature, (Akin-Tepede 2010; Bishop and Amos,2015).

Over the past decade, there has been a significant growth in the use of tricycles as a commercial public transport mode in countries in sub-Saharan Africa, Latin America, and Asia (Kumar et.al 2016). Despite the major part played by tricycles transport service in public transport, little is known about their origin, cost structure, environmental, ridership characteristics, the political economy and other impacts (Kumar, et.al 2016). The recent influx of affordable tricycles into Nigeria is creating a revolution in mobility and accessibility.

There are many types of tricycle in Nigeria, but the most commonest is the "Bajaji", the name was driven from Indian manufacturing company known as Bajaj which was among the first suppliers of tricycles in Tanzania (Bishop and Amos 2015). By use of Bajaji (Figure 1) as also contributed to the environmental pollution especially in the urban areas.
The most critical component of the Bajaj Tricycle is the engine. A 6.6kW, 5000 rpm engine are mostly used by the Bajaj tricycle. It is four (4) stroke spark ignition and its uses forced air cooling system. It also has 63.5mm x 62.8mm bore x stroke and an engine displacement of 198.88cm^3. The tricycle engine communicate its engine by-product to the environment via the exhaust system.(Bajaj RE 45 petrol-CNG-LPG-Fi User's Guide).
The exhaust system carries exhaust gases from the engine's combustion chamber to the atmosphere. Exhaust noise of internal combustion engines is known to be the biggest pollutant of the present-day urban environment.(Bajaj RE 45 petrol-CNG-LPG-Fi User's Guide).

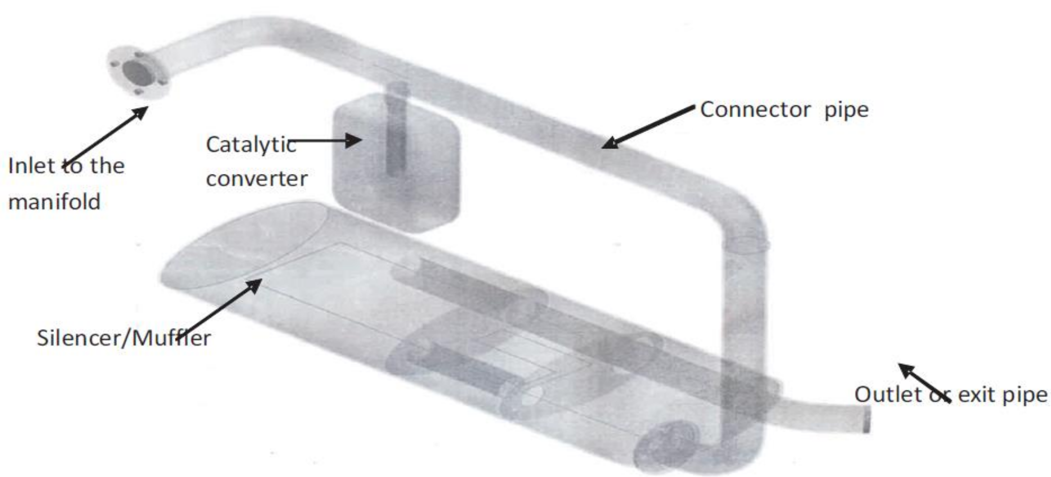

Figure 1: Bajaj Exhaust system.

Exhaust gases leave the engine in a pipe, traveling through exhaust manifold, catalytic converter and a muffler before exiting through the tailpipe. There are various design that are available today, in which the only difference is the way they handle the amount of gasses released through the exhaust manifold. The engine and exhaust system performance and life cycle is affect by backpressure, temperature also the passenger and environment are affected by the exhaust noise level (Mayer, 2004).
Back pressure represents the extra static pressure exerted by the muffler on the engine through restrictions in the flow of exhaust gases. Unlike back pressure, noise has to be considered for its effect towards the environment.
The Engine exhaust backpressure is the exhaust gas pressure that was produced by the engine to overcome the hydraulic resistance of the exhaust system at the outlet of the exhaust manifold (Mayer, 2004).

Procedure for Measuring Backpressure and Noise Level

1. The temperature, pressure and sound sensor was installed in the hardware of the computer system.
2. The sensors are linked together in an IMC multi-channel system which is in turn linked to the workstation (Tricycle motor) via a USB cable.

3. The sensors are well set with a program that measured the backpressure and noise level simultaneously.
4. The results obtained was printed which further indicate the variation between the engine speed in rpm and noise level at one hand and the engine speed and pressure level (bar) for the backpressure on the other hand.

Results and Discussion of the Results

This chapter presents results of computational fluid dynamics (CFD) and experimental analysis of the effect of noise and backpressure of a tricyclic exhaust.

Experimental Results

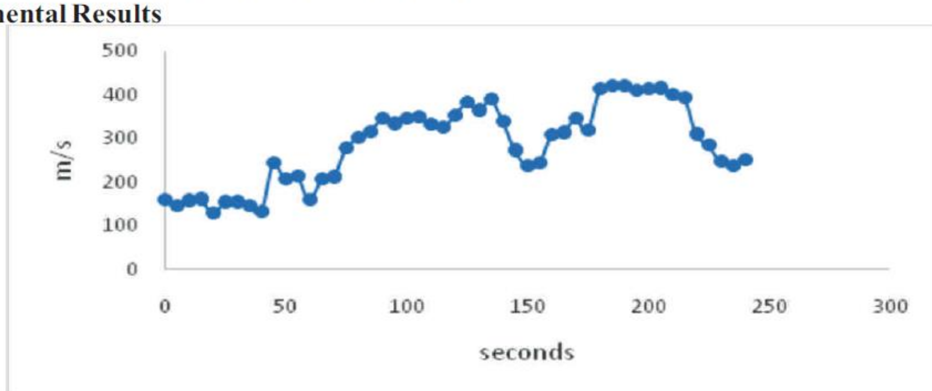

Figure 3: Experimental exhaust gas velocity while the tricycle is unloading.

The exhaust velocity at the outlet of the muffler when the tricycle was stationary is presented in figure 3. The graph shows a lowest of 129.12 m/s, highest 419.12 m/s and average 285.57 m/s.

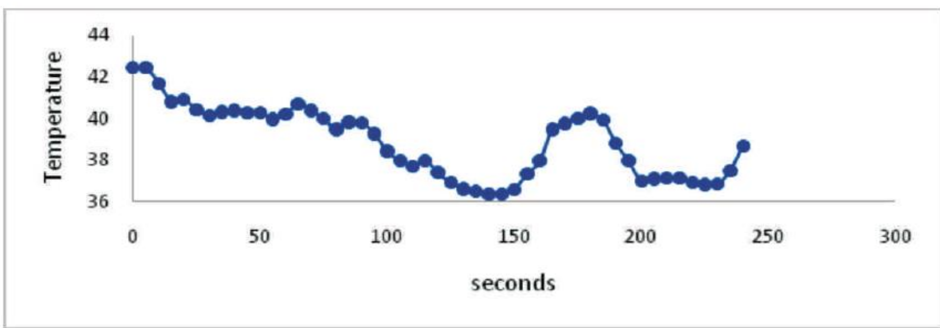

Figure 4: Experimental exhaust gas temperature while the tricycle is unloading.

Figure 4 shows the experimental temperature at recorded by the sensor placed end of the gas outlet pipe of the muffler. Its shows an average drop on the temperature of the gas as it exist. The lowest temperature of 38.87°C at the exits pipe.

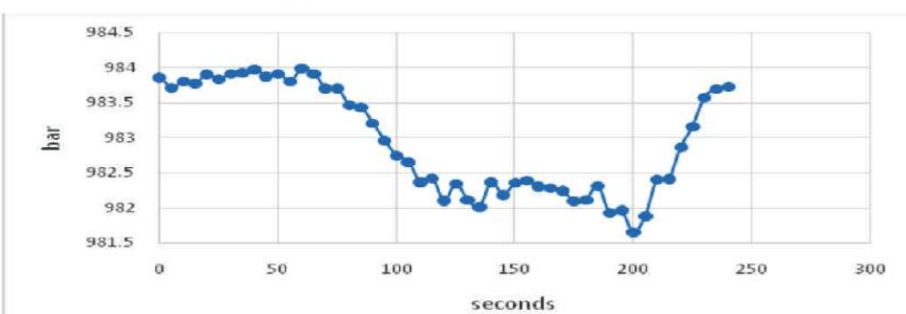

Figure 5: Experimental exhaust gas pressure while the tricycle is unloading.

As the engine runs at a stationary position, the pressure at exit pipe were the sensor were place is shown in Figure 5 at the stationary position, the pressure recorded is 982.97 bar.

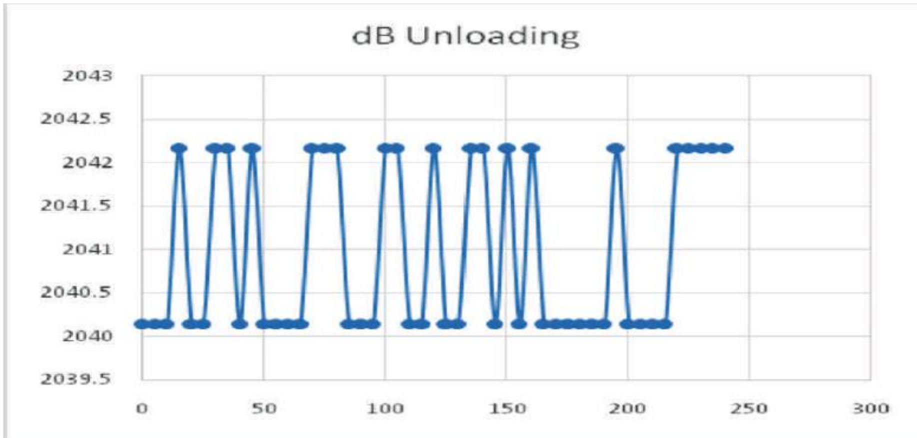

Figure 6: Experimental exhaust gas sound while the tricycle is unloading.

A 2042pa sound pressure was recorded for the tricyclic motor while it was loaded. The values are computed to 78 db (A) and this is more than the recommended sound levels for urban night period.

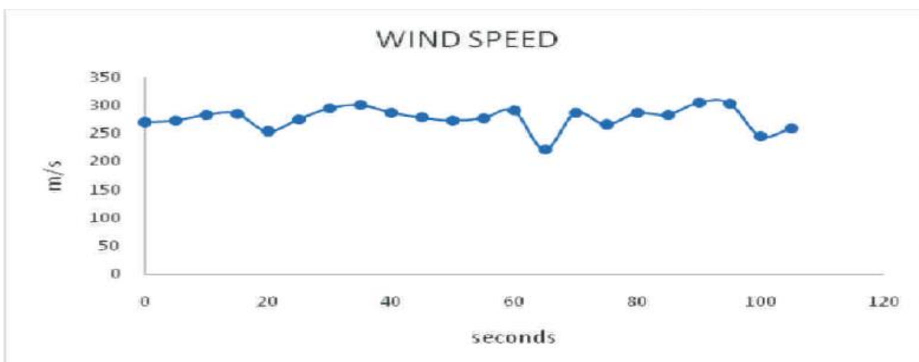

Figure 7: Experimental exhaust gas velocity while the tricycle is loading.

The exhaust air velocity recorded during experimentation has a maximum 330m/s, minimum 209m/s and an average velocity of 255m/s. The linear nature of the exhaust velocity may be as a result that the experiment was conducted on a flat road surface.

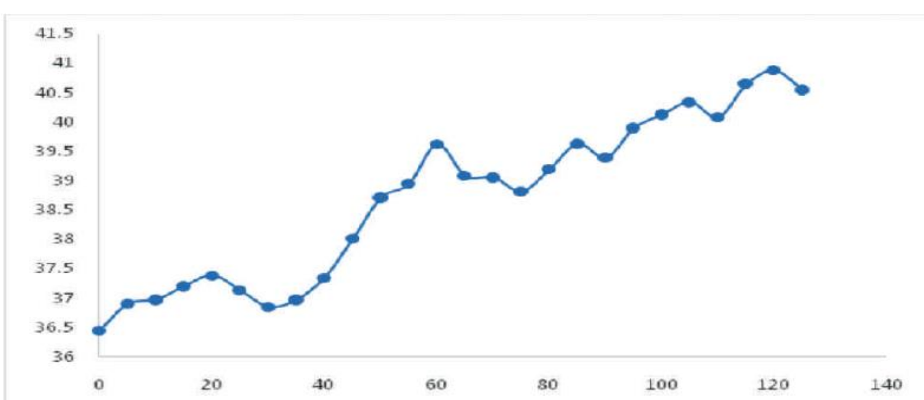

Figure 8: Experimental exhaust gas Temperature while the tricycle is loading.
The exhaust temperature raises from normal room temperature to about 62°c in about an hour with a slope of 0.04

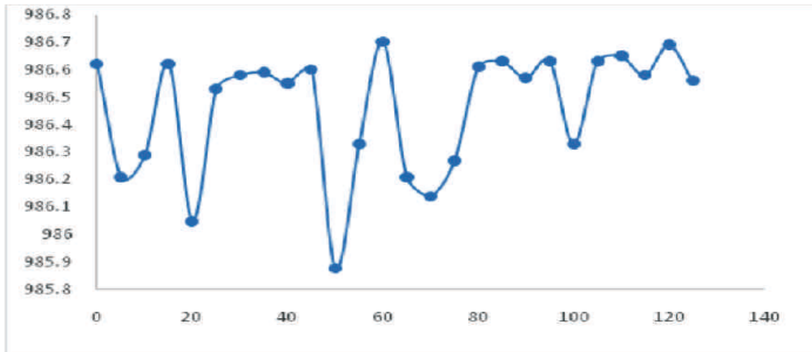

Figure 9: Experimental exhaust gas Temperature while the tricycle is loading.
Figure 9 present the pressure of the exhaust gas recorded experimentally. This shows that the pressure drop for about 101483.5 atmospheric to normal atmospheric pressure. This also shows that pressure is higher at the middle chamber of the exhaust manifold.

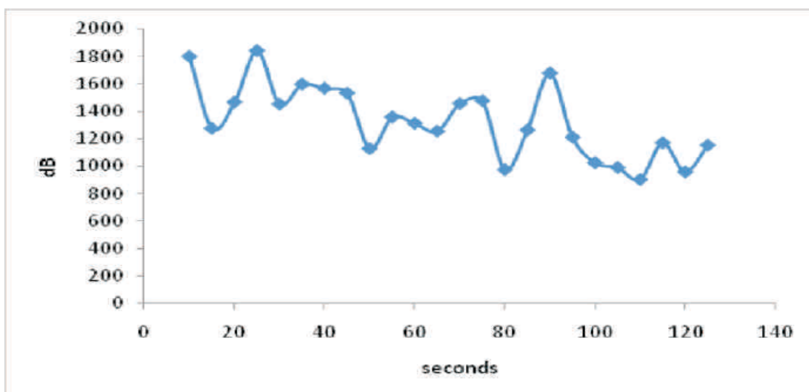

Figure 10: Experimental exhaust gas sound while the tricycle is loading.
Noise pollution in the form of sound pressure from the tricycle recorded was 1800 and this is below 78dB, this value is more than the result for urban areas for night and day period.

Conclusion

An experimental analysis of noise and backpressure exhaust system was carried out successfully, in order to estimate the flow profile of the muffler and determine the backpressure, noise level, flow temperature and velocity. For this experiment, the following conclusions were drawn. The velocity shows a maximum and minimum velocity of 419.12m/s and 129.12m/s for unloading. While loading has a maximum of 330m/s and minimum of 209m/s. The temperature was recorded by placing the sensor at the exit pipe of the muffler with an average drop in temperature of 38.87°c for unloading and 62°c for loading.

As the engine runs at a stationary position, the pressure at the exit pipe was 2.97 bar for unloading. While for loading the pressure drop for about 101483.5 bar to normal atmospheric pressure.

The noise or sound level recorded was computed to 78dB(A) which is more than the recommended sound level for urban night period for both loading and unloading.

Recommendation

Based on the experimental analysis carried out through this research work, the following recommendations were made.

1. The Department of Mechanical Engineering should purchase a data logger unit that will assist both undergraduate and postgraduate student in carrying out experiments and research topics similar to this project
2. Further work should be carried out on the exhaust chamber pipe diameter by varying the diameters; or introduce another pipe material that will reduce the sound level of 78dB(A) at night to an acceptable range.
3. Since model work that requires numerical calculations was not one of the objective of this research, further research work should be carried out using a model.
4. The university authorities should purchase licence software like Solid works, ANSYS, ADINA etc to enable research students carry out simulation and CFD analysis.

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