DESIGN OF EXHAUST SILENCER MUFFLER FOR TRANSMISSION LOSSES WITH THE PERFORMANCE OF A FOUR STROKE DIESEL ENGINE WITH AND WITHOUT MUFFLER SECTION

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ABSTRACT

The environment affected inherent drawback from IC engines is concerned to the major mankind of exhaust noise pollution and air pollution. However the exhaust noise can’t be identified, but the human being affected by without destiny. This paper decided to done the research work depend on the noise pollution for optimum design and construction of the muffler and internal sections. The muffler section has changed but back pressure replied to the engine, might increased and hampered to the engine. The present work done by improving the thermal efficiency and improved the combustion efficiency by exhaust silencer. In addition that, the performance test and engine efficiency results were compared with existed method in term of brake thermal efficiency and brake specific fuel consumption, temperature measurement of engine performance and drop of pressure measurement these drop of pressure and temperature measurements are observed.

Key words: Muffler, Silencer, BSFC, BTE

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1. INTRODUCTION

There are five different design criteria in mufflers design. These are acoustical, aero dynamical, mechanical, geometrical and economical criteria. The acoustical criterion specifies the minimum noise reduction required from the muffler as a function of frequency. A high intensity pressure wave generated by combustion in the engine cylinder propagates along the exhaust pipe and radiates from the exhaust pipe termination. The pulse repeats at the firing frequency of the engine which is defined by $f = \frac{\text{engine rpm} \times \text{number of cylinders}}{120}$ for a four stroke engine.

A dissipative muffler uses sound absorbing material to take energy out of the acoustic motion in the wave, as it propagates through the muffler. Reactive silencers, which are commonly used in automotive applications, reflect the sound waves back towards the source and prevent sound from being transmitted along the pipe. Reactive silencer design is based either on the principle of a Helmholtz resonator or an expansion chamber, and requires the use of acoustic transmission line theory.

2. LITERATURE REVIEW

The muffler used to controlled the noise level by developing an exhaust muffler for single largest contribute for overall noise of engine. Further, developed paper researched from TATA INDICA TURBO MAX TDI BSIV four cylinder diesel engine car was tested under the measurement or dimension of muffler created in CATIA, HYPERMESH using FEA method NASTRAN software simulated M. Rajasekar Reddy et al.,(1). This paper discussed by CFD approached with calculation on transfer matrix of engine exhaust muffler with flow and without flow. The engine exhaust has measured for noise reduction without mean flow and further employed the acoustic performance of muffler flow suggested to predict the acoustic performance and complex mean flow and without flow able to measure in CFD Lian –yun LIU et al.,(2).

The previous paper discussed about with mean flow and without mean flow of exhaust noise reduction. The experiment done by the same mean flow passes through the exhaust outlet. There were created and external accessories used to done the noise reduction by technical said as the fluctuation in volume. Finally the active silencer is capable to reduce the exhaust noise from 91 dBA to 78 dBA after tail pipe outlet with the back pressure of 3 Kpa to engine by R.Boonen.P.sas et al., (3) the presented details are absorption muffler and compare with the predictions of WAVE. The effect can easily calculate the absorption muffler for WAVE. The absorption muffler ensured the distinct effect on exhaust noise in lower range frequencies obtained Rolf jebasinki et al., (4) the design investigation of an exhaust system for V6 gasoline engine by using WAVES and KADOS. The influence of several parameters and designed of exhaust noise and engine performance measured and shown Carsten Sartorius et al., (5)

3. EXPERIMENTAL DESIGN & METHODS

In a two point method, transmission loss is evaluated from the field pressures measured at two points inside the muffler. Among the two points, two of them (points 1 and 2) are located in the inlet pipe and one in the outlet pipe. The two field points in the inlet pipe are used to extract the incoming wave pressure $p_i$.

The field point pressure at point2 is the same as the transmitted wave pressure $p_t$ in the outlet pipe, that is $p_2 = p_t$. This is due to the specification of anechoic termination at the outlet, which by definition does not reflect waves back into the outlet pipe. Due to the discontinuity in the impedance from the inlet pipe to the expansion chamber of the muffler, apportion of the incoming wave is reflected back to the source. Hence, pressures measured at points 1 and 2 in the inlet pipe are resultant of both the incoming ($p_i$) and reflected ($p_r$) waves and are given by [3].

\[
\begin{align*}
P_1 &= p_i e^{ik_1} + p_r e^{ik_1} \\
P_2 &= p_i e^{ik_2} + p_r e^{ik_2}
\end{align*}
\]
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Figure 1 Muffler Cross Sectional Area

Where \( p_1 \) and \( p_2 \) are the pressure valves, \( x_1 \) and \( x_2 \) are the locations of point 1 and point 2 respectively:

The solving equation \( P_1 \) and \( P_2 \), obtained equation \( P_i \),

\[
P_i = \left( \frac{1}{2} \rho \sum_{k=1}^{n} k \rho L \right) \left( \frac{r_1^2}{2} - \frac{r_2^2}{2} + \frac{r_1^4}{4} - \frac{r_2^4}{4} \right)
\]

We used to compute field point pressures at the two field points at 1 and 2

3.1. Fabrication of Reactive Muffler

Table 1 Muffler Specifications

<table>
<thead>
<tr>
<th>Specification of Muffler Design</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>GI</td>
</tr>
<tr>
<td>Length of the Sheet</td>
<td>1500mm × 500mm</td>
</tr>
<tr>
<td>Diameter of Exhaust Pipe</td>
<td>400mm</td>
</tr>
<tr>
<td>Diameter of Inner Pipe</td>
<td>250mm</td>
</tr>
<tr>
<td>Length of outer Pipe</td>
<td>300mm</td>
</tr>
<tr>
<td>Welding</td>
<td>Gas Welding</td>
</tr>
<tr>
<td>Medium</td>
<td>Helium (Inert Gas)</td>
</tr>
</tbody>
</table>

Figure 2 shows the details and assembly drawing of the reactive muffler. Component 1 is a M.S. pipe of 63.5 mm diameter and 200 mm length. The wall thickness of the inlet pipe is about 2mm. Component 2 is the hollow cylinder of 200 mm diameter and 750 mm length. The hollow cylinder was prepared by cutting M.S. plate of 3 mm thickness as per given dimensions. The plate was bent to the truly cylindrical shape with the help of solid cylinder of 200 mm diameter and 750 mm length.

The edge of the plate and muffler plates was welded by electric arc welding and gas welding, which consists of welding tool, Design for manual manipulation by the user and an helium inert gas cylinder and electric power unit. Component 3 is the cover plate. The two side cover plates were welded to the hollow cylinder, inlet and outlet pipes are welded to the cover plates as shown above in the figure. Thus assembly of the reactive muffler was carried out as shown in the assembly drawing.
3.2. Experimentation

The background noise was measured before starting the experiment. All engines another machines were shut down during testing of mufflers and also while measuring background noise. This is to avoid local disturbances. The sound level meter was used for measuring sound pressure level and it was positioned at a distance of one meter away from the outlet of muffler and at an angle. The meter was positioned at the same level that of flow of exhaust gas so that the noise level can be recorded effectively. The 4-stroke diesel engine was started. The readings were observed at 1200 rpm, as reactive muffler is most effective at low frequencies and different torque(loads); no load, 50 Nm, 150 Nm, 200 Nm.

The engine was operated at different load and fixed speed. The measurements of fuel supply is recorded i.e., time was recorded for consumption of 50 ml of fuel from calibrated burette. The rate of fuel consumptions in kg/hr was calculated. This data further helped in calculating BP and BSFC. The sound pressure level was recorded before starting of engine or pump or dynamometer. The background noise level was recorded. Room temperature was also recorded. Then sound pressure level was observed at above mentioned speeds and loads. The metallic bulb of thermocouple was inserted in the outlet pipe of the muffler and exhaust gas temperature was recorded. The sound pressure level also depends on exhaust gas temperature.
The tube of water filled manometer was attached to inlet pipe and outlet pipe of muffler. The drop of pressure across the muffler was recorded in mm. This data will help in calculating the amount of back pressure exerted on the engine. The experiment was repeated for all types of muffler, i.e., reactive, existing and without muffler.

4. RESULTS AND DISCUSSION

Figure 4 Comparison of Thermal Efficiency Vs Brake Power

Figure 6 represents the comparison of brake thermal efficiency among existing, developed and without muffler at 1200 rpm. The maximum brake thermal efficiency without muffler, with existing muffler and with developed and fabricated mufflers are 25.84, 23.64, and 24.89, respectively. The brake thermal efficiency with developed muffler is little less than the without muffler, because of the higher pressure drop in case of developed muffler in comparison to without an existing mufflers.

Figure 5 Comparison of Brake Specific Fuel Consumption Vs Brake Power

Figure 5 represents the comparison of BSFC among developed, existing and without muffler. Here it can be seen that BSFC is 0.323 when it is without muffler. When the existing muffler is used, BSFC becomes 0.354. For developed and fabricated muffler BSFC is 0.336.
Figure 6 Comparison of SFC Vs BTE

The above graph represents the drop of pressure at 1200 rpm with developed and existing muffler. It is interesting to note down that the pressure drop for developed fabricated muffler is higher than the existing muffler.

5. CONCLUSIONS

From results and discussions the following conclusions are drawn:

- The brake thermal efficiency of engine is higher for developed and fabricated muffler as compared to existing muffler.
- The brake specific fuel consumption is low compared to existing muffler.
- Maximum transmission loss is approximately 20 db for developed and fabricated muffler.
- The fuel consumption is less compared to existing muffler.

REFERENCES


[5] Carsten Sartorius and Daimler Chrysler, “Simulation of exhaust orifice noise for designing the exhaust system of a V6 engine”.


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