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Enhancement of Engine Performance through analyzing internal part design on Modenas CT115s exhaust using CFD Simulation

Efi N E[1], Shahriman A B[1], Rojan M A[1], I Zunaidi[1], Z M Razlan[1], W K Wan[1], M S M Hashim[1], N S Kamarrudin[1], A Harun[2], I Ibrahim[1] and Azizul Aziz I[3]

[1] School of Mechatronic Engineering, Universiti Malaysia Perlis, Pauh Putra Campus, 02600 Arau, Perlis, Malaysia.
[2]School of Microelectronic Engineering, Universiti Malaysia Perlis, Pauh Putra Campus, 02600 Arau, Perlis, Malaysia.
[3]Modenas Research and Development Divison, Kawasan Perusahaan, 08300 Gurun, Kedah.

Corresponding author: shahriman@unimap.edu.my

Abstract Exhaust is made to make a way that guide and expel exhaust gasses far from the engine. Inside exhaust system, there are four noteworthy parts which are muffler, perforation, resonator chamber, inlet and outlet. For mechanical performance of perforated resonator can be controlled by size of holes. The aim of this paper is to analyzing internal part geometry of exhaust muffler in order to increase Modenas CT115s performance by using Ansys software as a programmed to calculate the velocity magnitude and the flow rate of exhaust muffler. Consequently, high proficiency inside the exhaust system will create a brilliant execution and high quality performance. From the simulation shows that decreasing the size of holes give ultimately impact to performance of exhaust.

Keywords: exhaust, mass flow rate, velocity magnitude, perforated tube holes, engine performance.

1. Introduction

Focusing on exhaust system for the four stroke engine, inside exhaust system, there are four noteworthy parts which are muffler, perforation, resonator chamber, inlet and outlet. Basically, exhaust system also known as muffler is made to route exhaust gases away from the engine. When the fuel is burn inside the engine, the fume and gases produced need to be taken away to avoid performance engine loss. The muffler also captures harmful toxins in gases before they are released to the atmosphere. It is made to make a way that guide and expel exhaust gasses far from the engine. [1]. consequently, high proficiency inside the exhaust system will create a brilliant execution and high quality performance. Each part conveys a function that suit with its purpose. To start with designer of suppressor design was granted to Milton O. Reeves and Marshall T. Reeves [2]. Essentially mufflers are characterized into two classes which are dissipative and reflective. In dissipative muffler, pressure waves is change over into heat energy by using the principle of converting exhaust noise energy. Next, reflective muffler utilizes complex muffler parts to create pressure waves that will counteract the dynamic pressure wave with approaching pressure [2, 3]. Selection of suitable muffler is based on transmission loss and it is vary with changes in geometry parameters such as number of holes, diameter of pipe and number of pipes

[3]. A lot of literature review had been made to enhance the performance of engine by designing diverse mufflers with various diameter of the perforated hole, distinctive length of the perforated tube and different perforated holes design [7]. Perforated tubes is a tube that generally made up with stainless steel and have gaps or hole punched around its outline. These tube are given to control the stream of the gasses all through the exhaust muffler [3, 4]. One of its significant capacity is to expand the transmission loss thus will increase the performance of the engine. From the study, it has been observed that the number of holes and the size of the hole in the perforated tube affects the amount of transmission loss in the mufflers [5, 6, 8]. The bigger the diameter of the hole, lower will be the backpressure and hence lower will be the transmission loss. Length of perforated tube likewise considerably affects the transmission loss and it increase with the increasing in the length of the perforated tube [4, 6].

2. Methodology

2.1. CATIA V5 Software

To calculate the exhaust profile the parameters that influence the motion of the exhaust mufflers need to be identify first by using CATIA V5. The exhaust dimensions need to be analyze and identified before continuing to the experiment. In this research, the method had been used are by CATIA V5 software to identified the part. The software that has been utilized to display the air flow is CATIA V5. Perforated tube can be redesign by changing its holes diameter whether to increase the diameter or decrease the diameter. The air flow modeling in this project is been divided into two groups which is the existing design and the improvement design.

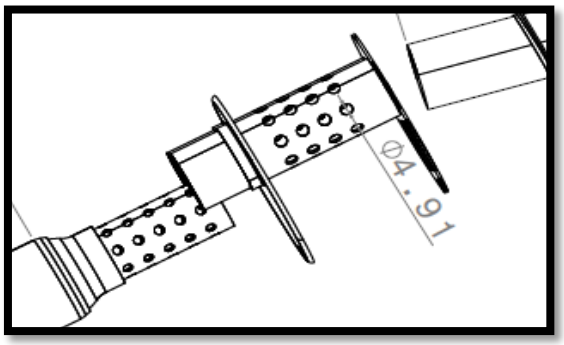


Figure 2.1: Dimension for existing design of perforated tube holes

Table 1: Existing and improvement diameter

Design	Existing Diameter (mm)	Improvement Diameter (mm)
A	4.91	4.41
B	4.91	3.91

2.2. ANSYS Workbench 15.0 Software

The actual design of the air flow model is created based on exact dimension of the CT115s engine's exhaust. Next, it is import into ANSYS Workbench 15.0 software. In the mesh generation, proper steps should be conducted properly to avoid failure in analysis. If there is improper mesh define, the fluid zone will cause failure. The critical area need to be choose carefully especially for the inlet, outlet and wall part body. For the existing design, the approximate meshing cell are shown in figure 2.2.

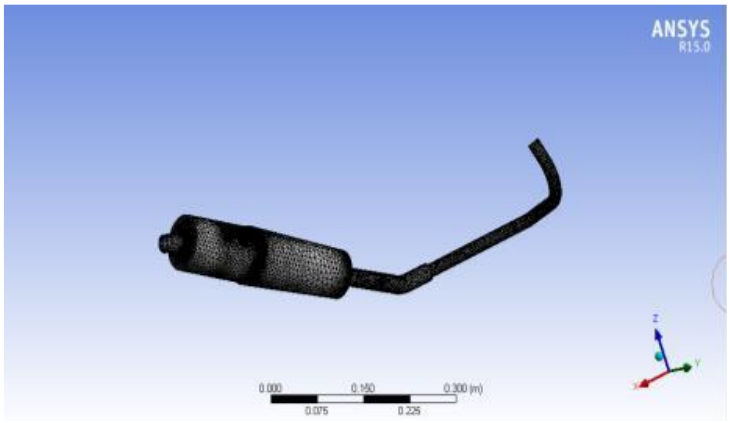
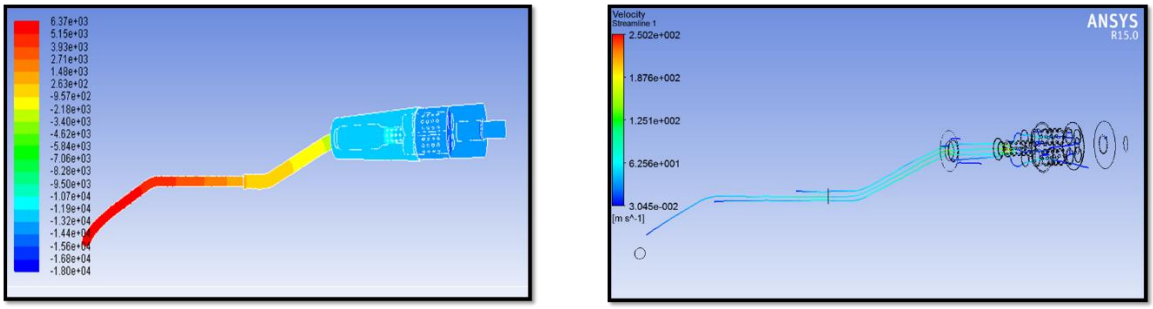


Figure 2.2: Existing MODENAS CT115s exhaust design Meshing cell analysis

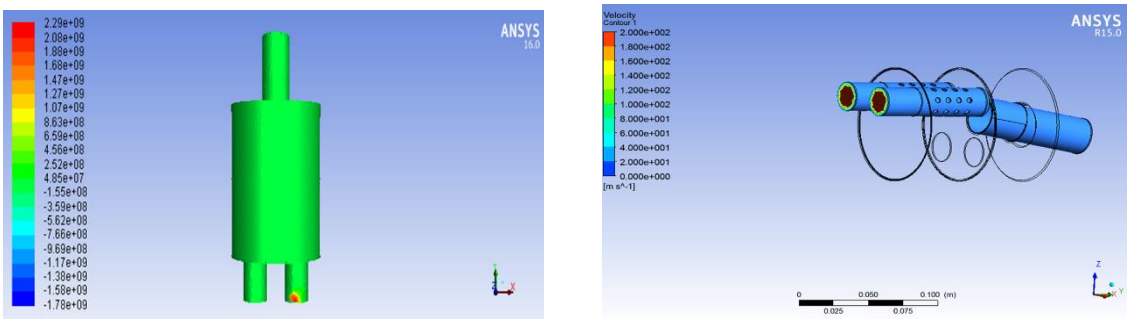
3. Result and Discussion

Exhaust Modenas CT115s and proposed design has been tested by using ANSYS Workbench 15.0 software to determine the velocity air flow and the pressure. All the design then undergo different type of analysis test. From the figure 3.1 until 3.3, shown the velocity streamline and pressure contour for the actual and improvement design part of exhaust muffler. The red colour in both figures indicates the maximum values while the blue colour indicates the minimum values.



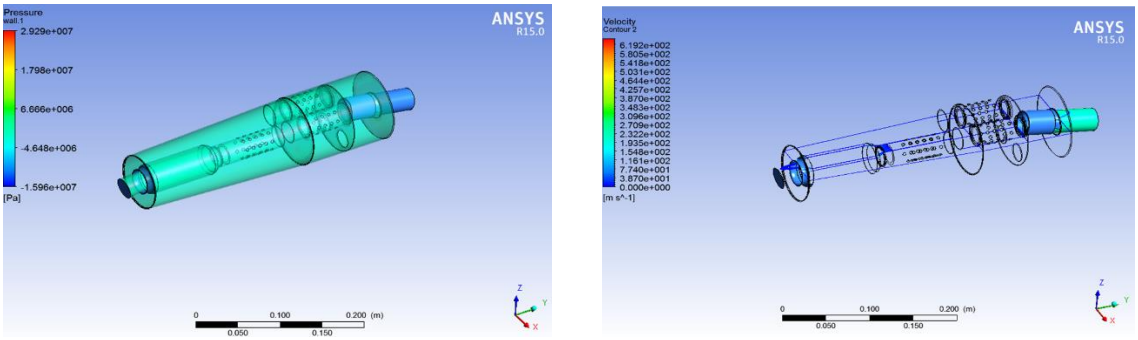
(a) (b)

Figure 3.1: Pressure contour (a) and velocity magnitude (b) for existing design



(a) (b)

Figure 3.2: Pressure contour (a) and velocity magnitude (b) for Design A



(a) (b)

Figure 3.3: Pressure contour (a) and velocity magnitude (b) for Design B

Increasing the size of hole in exhaust make a huge different in simulation result. For the mass flow rate result at improvement design B show that the mass flow is 0.15644 kg/s which is the highest compared to the others design. Different result shows at the existing design result which is 0.03256 kg/s much lower than improvement design B. For velocity magnitude design B also improve from 1.876e2 m/s for existing design to 6.192e2m/s. Table 2 shows all the result for all design.

Table 2: All the result for all design

	EXISTING DESIGN	DESIGN A	DESIGN B
MASS FLOW RATE (KG/S)	0.03256	0.10345	0.15644
VELOCITY MAGNITUDE (M/S)	1.876e^2	2.0×10^{2}	$6.192e\times10^{2}$
PRESSURE (PA)	6367.66	-1.7838×10^{9}	2.929×10^{7}

4. Conclusion

Based on the research and analysis that had been done for internal part of exhaust which focusing on redesign the perforated tube in the muffler, the size of hole give ultimately impact to the performance of gases flow out to the surrounding. In this research, diameter of hole is decreasing 0.5mm from existing value. From the simulation result clearly shows that smaller the size of holes give higher performance in term of mass flow rate and velocity. For this research, conclusion can be make as lower the value of diameter for perforated tube will contribute to higher performance of exhaust. Therefore, for the future work, the optimum value for size of hole and number of holes are suggested to be investigate in detail for general small engine.

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