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EXPERIMENTAL TEST OF *TURBO INSULATOR* ON *INTAKE MANIFOLD* ON ENGINE PERFORMANCE

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Abstract: *Engine performance refers to the capability of an internal combustion engine to convert input energy, specifically fuel, into useful power. One method to enhance engine performance is to modify components of the intake system that affect airflow. A turbo insulator, which is a modified gasket connecting the carburetor to the intake manifold, is designed to generate turbulent airflow into the combustion chamber, thus improving combustion efficiency. This study aims to design and evaluate a turbo insulator on the intake manifold of a Suzuki Shogun NR-125 CC motorcycle through experimental testing of its impact on engine performance—specifically torque and power. A descriptive analysis method was employed for data analysis. Engine performance testing was conducted using an engine dynamometer, following ISO 1585 standards, within an engine speed range of 3,000 to 9,000 rpm, under standard factory conditions and with various turbo insulator configurations (5 and 7 blades, 45° and 60° blade angles, 4 mm and 8 mm thicknesses). The results indicate that the turbo insulator improves engine performance. The most optimal configuration, V-5 (5 blades, 45° angle, 8 mm thickness), achieved a maximum torque of 11.27 Nm at 3,500 rpm and a maximum power output of 10 HP at 7,750 rpm, representing increases of 0.39 Nm and 0.3 HP compared to the standard setup.*

Keywords: *Engine performance, Turbo insulator, Intake manifold*

1. INTRODUCTION

In today's modern era, technological advancements in the automotive sector are rapidly progressing, driven by the demand for powerful, efficient, and environmentally friendly vehicles. Current concerns in the automotive industry include improving engine performance (torque and power), fuel efficiency, the use of eco-friendly alternative fuels, reducing exhaust emissions, and compact engine design (Faturrochman & Yaasiin, 2024; Singla et al., 2015; Wahyu et al., 2019). In Indonesia, motorcycles powered by gasoline engines are the most widely used type of vehicle, as reported by the Central Statistics Agency (2024). This dominance indicates the importance of innovating engine component designs to enhance performance, thereby improving the overall efficiency of these engines.

Internal combustion engines (ICEs) are capable of generating significant mechanical power through fuel combustion within a combustion chamber, while maintaining relatively compact dimensions (Hartanto et al., 2019). One of the key components that significantly influences engine performance in motorcycles is the intake manifold (Alexander & Ruhyat, 2024). The intake manifold serves to deliver the air-fuel mixture from the carburetor to the combustion chamber based on the engine's needs (Singla et al., 2015). Design improvements and the addition of components can reduce energy losses and enhance various engine efficiencies, including volumetric, thermal, combustion, and mechanical efficiencies (Sunaryo et al., 2020).

Enhancing the performance of gasoline engines can be achieved by modifying intake system components related to airflow (Badr et al., 2022). Proper intake manifold design can improve volumetric efficiency (Hadjkacem et al., 2019), thereby increasing torque and power output (Silva et al., 2019), as well as reducing exhaust emissions and fuel consumption across different engine speeds (Adithya et al., 2020). Optimizing volumetric efficiency is a proven method for improving intake manifold performance (Kaplan & Aydogan, 2020). A higher intake air pressure increases air density, enabling more complete combustion in a shorter time frame, leading to improved fuel consumption efficiency and power output, and reduced emissions (Dziubak & Karczewski, 2022).

In spark-ignition engines, the intake manifold supplies the air-fuel mixture to the intake ports of the cylinder head (Shah et al., 2014). Under standard conditions, the airflow during the intake stroke is typically laminar, which results in less effective fuel atomization (Sunaryo et al., 2020). Turbulent flow is required to create a more homogeneous mixture (Al-Kayiem et al., 2017; Çeper et al., 2016) and improved atomization for more complete combustion (Tyagi et al., 2015). The characteristics of airflow within the intake manifold significantly affect engine performance (Demir et al., 2022). Generally, turbulence in the intake port can be enhanced by adding a turbo cyclone, which implies introducing new components into the system. Therefore, a modified insulator was developed—without introducing additional parts—serving both as an air-sealing gasket and a device to generate turbulent airflow, termed a turbo insulator. The blade design of the turbo insulator induces turbulent airflow, increasing the speed of air intake into the manifold, thereby improving mixture homogeneity (Al-Kayiem et al., 2017), enhancing combustion intensity, flame stability (Tyagi et al., 2015), and flame propagation speed (Çeper et al., 2016), resulting in more efficient combustion.

The Suzuki Shogun NR-125 CC is a widely used motorcycle in Indonesia due to its reliability and fuel efficiency. Despite its relatively small engine displacement, it is well-known as a "motor badak" (tough motorcycle). However, no studies have specifically examined the impact of turbo insulator installation on this particular model's engine performance. Therefore, further research is necessary to analyze how turbo insulators influence torque and power output in this model.

To investigate this, the dynotest method was employed, which provides accurate data on engine torque and power. The quantitative data obtained through dynotesting facilitates analysis of the extent to which turbo insulator usage affects engine performance. Thus, this study aims to design a turbo insulator for the Suzuki Shogun NR-125 CC intake manifold and experimentally test its impact on performance. This experiment also seeks to identify the optimal turbo insulator design for maximizing torque and power. The findings are expected to contribute to innovations in the development of more efficient automotive technologies.

2. ENGINE PERFORMANCE PARAMETERS

Engine performance is the ability of a combustion motor engine to convert incoming energy, namely fuel, to produce useful power (Purnomo et al., 2024). There are several factors that can affect engine capability including volumetric efficiency, fuel quality, compression ratio, and cylinder volume (Ingale & Bajaj, 2020). To determine the performance of a gasoline engine, there are several performance indicators, among others:

A. Torque

Torque is an indicator of the engine's ability to perform work, namely moving the motor from a standstill to running (Saputra et al., 2021). Torque is related to acceleration and lower engine speed. The more perfect the combustion of an engine, the more torque it will get. With this torque, it causes the object to rotate on its axis and the object will stop if there is an effort against the same torque in the opposite direction. Torque (T) can be formulated as follows:

$$T = 716,2\ x \frac{Ne}{n} \quad (1)$$

Description:

T	= Torque (Nm)
Ne	= Effective power (HP)
n	= Engine speed (rpm)

B. Power

Power is a term used to express how much work can be done in a certain period of time (Saputra et al., 2021). The power produced by an engine can be divided into two, namely indicative power and effective power. Indicative power is the power generated from the combustion reaction of fuel with air that occurs in the combustion chamber (Fauzi, 2018). Indicative power (*Ni*) can be formulated as follows:

$$Ni = \frac{P_i\ x\ Vd\ x\ n\ x\ i}{0,45\ x\ z} \quad (2)$$

Description:

Ni	= Indicative power (HP)
Pi	= Average indication pressure (kg/cm²)
Vd	= Stroke volume of one cylinder (m³)
n	= Engine speed (rpm)
i	= Number of pistons
z	= Number of crankshaft revolutions for each 4-stroke engine cycle (z = 2)

Effective power is proportional to the multiplication of the torque that occurs on the output shaft (*T*) with the working rotation (*n*) (Fauzi, 2018). The working rotation of the shaft which often changes, especially in motorized vehicle engines, the amount of torque on the shaft (*T*) can be used as an indicator of the performance of the combustion motor. This power is generated by the crankshaft which is a change in heat in the combustion chamber into work. Effective power (*Ne*) can be formulated as follows:

$$Ne = \frac{T\ x\ n}{716,2} \quad (3)$$

Description:

Ne	= Effective power (HP)
T	= Torque (Nm)
n	= Engine speed (rpm)

3. RESEARCH METHODS

The research method used is an experiment that aims to analyze the effect of using a *turbo insulator* on the *intake manifold* of a Suzuki Shogun NR-125 CC motorcycle on engine performance. The independent variables of this research are *turbo insulators* with 5 and 7 *blades*, 45° and 60° *blade* angle slope, and 4 mm and 8 mm component thickness. While the dependent variable consists of torque (HP), and power (Nm).

Turbo insulator is a gasket connecting the carburetor with a modified *intake manifold*, made of *Nylon Carbon PA6-CF* material which has heat-resistant properties up to a temperature of 215°C. This innovation consists of *blades* that create a swirling or turbulent flow of air and fuel into the combustion chamber so that the mixing of air and fuel becomes more homogeneous and more complete combustion can be achieved. The dimensions of the *turbo insulator* are designed the same as the dimensions of the factory standard *insulator* on the Suzuki Shogun NR-125 CC motorcycle, which is 55 mm long and 35.8 mm wide as shown in Figure 1 below.

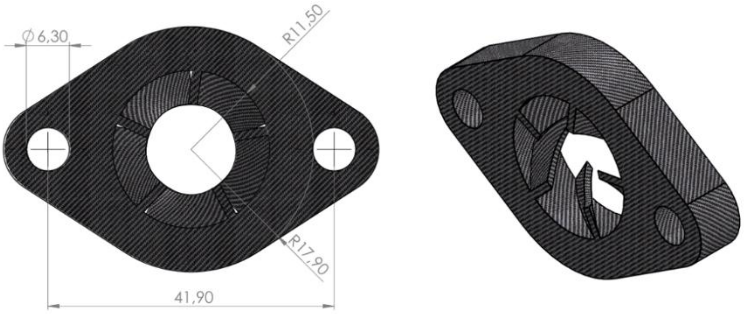

Figure 1. ***Turbo insulator***

The design of the *turbo insulator* is done using drawing *software* on a laptop or computer. The *turbo insulator* variation consists of the number of *blades*, the angle of inclination of *the blade*, and the thickness of the *turbo insulator* components as shown in Table 1 below.

Table 1. Variasi *Turbo Insulator*

No.	Code	Component Thickness	Total *Blade*	Slope *Blade*
1.	V-STD	Factory Standard	-	-
2.	V-1	4 mm	5	45°
3.	V-2	4 mm	5	60°
4.	V-3	4 mm	7	45°
5.	V-4	4 mm	7	60°
6.	V-5	8 mm	5	45°
7.	V-6	8 mm	5	60°
8.	V-7	8 mm	7	45°
9.	V-8	8 mm	7	60°

The testing instrument used is an *Engine Dynamometer* with specifications of *rolller* inertia of 3.79 kgm² with a diameter of 277 mm connected to *Sport Dyno 40 software* with a validation factor (ISO 1585). Engine performance testing is carried out at engine speeds of 3,000 - 9,000 rpm three times under standard conditions and *turbo insulator* variations to get the same or almost the same data and the highest data is taken from the results of three tests. This is done so that the data is valid and reliable in describing the actual torque data. Suzuki Shogun NR-125 CC motorcycle specification data is contained in Table 2 below.

Table 2. Specifications of the Research Object

No.	Specifications	Description
1.	*Manufacturing*	PT Indomobil Suzuki International
2.	Type, Year of Production	*Night Rider* (NR) - 125 FL, 2008
3.	Machine Type	4 Stroke, Air Cooling, SOHC
4.	Cylinder Content	125 CC
5.	*Max Power*	9.85 HP / 10 PS (8,000 RPM)
6.	*Max Torque*	9.6 Nm (6,000 RPM)
7.	Compression Comparison	9,6 : 1
8.	Cylinder Diameter	53.5 mm
9.	Piston stroke	55.2 mm
10.	Tank Capacity, Fuel Type	4.3 L, *Pertalite* RON 90

Before testing engine performance, motorcycles first go through a *tune-up* process. *Tune-up* is a process of checking and adjusting various motorcycle engine components thoroughly to optimize motorcycle engine performance. The *tune-up* consists of checking and cleaning the components of the *intake system* and *engine oil*. In the *intake system*, the carburetor is cleaned, the air filter is cleaned and replaced, and the *intake manifold* is cleaned. Then in the *engine system*, engine oil, engine oil filter, and engine oil *strainer* are replaced. Furthermore, a thorough inspection is carried out, especially on components that work during engine performance testing such as chain tension and rear wheel wind pressure.

The engine performance testing of the Suzuki Shogun NR-125 CC motorcycle was conducted using an Engine Dynamometer under standard factory conditions to measure torque and power output. The procedure involved preparing all necessary equipment and PPE, inspecting the motorcycle's intake system, securing it onto the dynamometer, and installing the tachometer sensor. After a warm-up period, motorcycle specifications were input into the Sport Dyno 40 software, and the test was performed across engine speeds ranging from 3,000 to 9,000 rpm using ISO 1585 as the correction standard. Tests were conducted first without the turbo insulator and then with various turbo insulator configurations (differing in blade count, angle, and thickness). Each configuration was tested three times, with the best result selected for analysis.

The scheme of the Suzuki Shogun NR-125 CC motorcycle engine performance testing instrument using an *engine dynamometer* is shown in Figure 2 below.

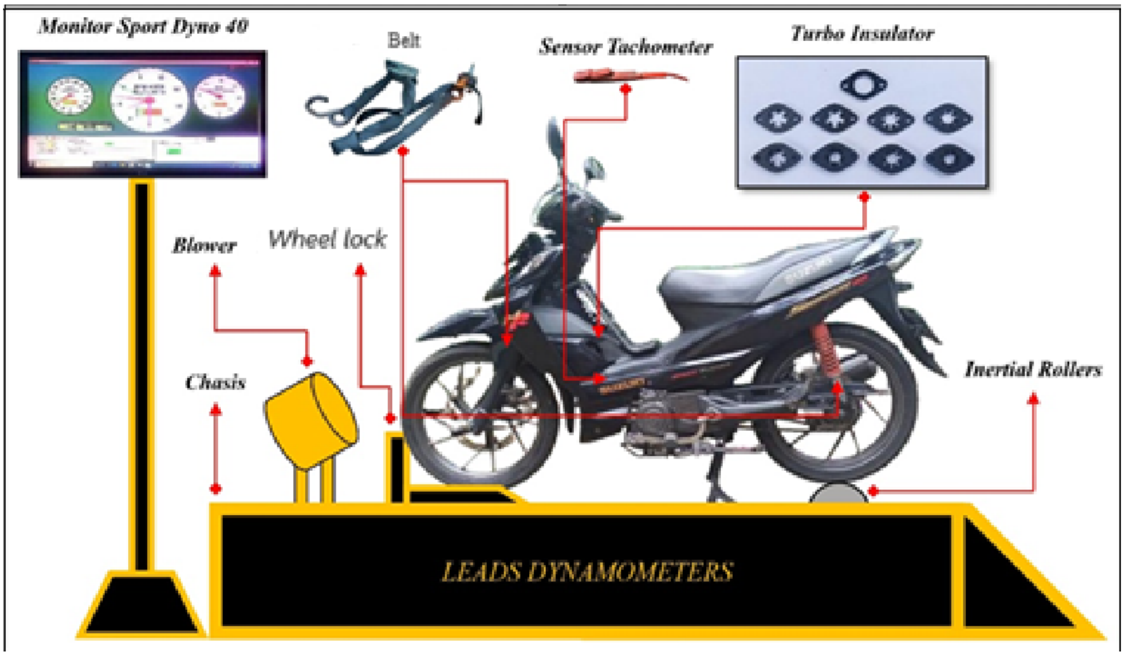

Figure 2. Schematic of Machine Performance Testing Instrument

The data analysis technique used in this research is descriptive analysis method. The test data is then processed in tabular form and presented in the form of diagrams or graphs of the relationship between the factory standard variation (without *turbo insulator*) and all *turbo insulator* variations to the torque and power produced. This is done to determine the phenomenon of engine performance that occurs before and after installing a *turbo insulator* on the *intake manifold* of a Suzuki Shogun NR-125 CC motorcycle.

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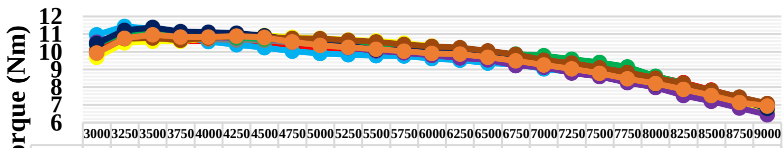
4. RESULTS AND DISCUSSION

The results of the Suzuki Shogun NR-125 CC motorcycle engine performance test carried out using a *Sport Dyno 40 Engine Dynamometer* at engine speeds of 3,000 - 9,000 rpm consist of engine torque and power data.

A. Engine Torque Testing Analysis

The analysis of torque testing of Suzuki Shogun NR-125 CC motorcycle under standard conditions and *turbo insulator* installation is shown in Figure 3 below.



	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000	6250	6500	6750	7000	7250	7500	7750	8000	8250	8500	8750	9000
V-STD	10,1	10,9	10,9	10,6	10,6	10,6	10,4	10,2	10,2	10,1	10	9,96	9,98	9,98	9,87	9,76	9,62	9,48	9,14	8,88	8,61	8,26	7,85	7,43	7,02
V1	11	11,4	11,3	10,9	10,6	10,4	10,2	10	9,91	9,84	9,78	9,76	9,62	9,53	9,37	9,3	9,04	8,85	8,68	8,51	8,21	8	7,63	7,25	6,9
V2	9,99	10,7	10,8	10,7	10,7	10,7	10,7	10,5	10,4	10,3	10,3	10,1	10	9,87	9,81	9,51	9,38	9,15	8,93	8,48	8,2	7,75	7,3	7	6,63
V3	9,7	10,5	10,6	10,6	10,8	10,9	10,9	10,8	10,8	10,7	10,6	10,5	10,3	10,1	9,89	9,71	9,46	9,21	8,9	8,66	8,29	7,81	7,44	7,02	6,62
V4	10,5	11,1	11,2	10,9	10,8	10,8	10,7	10,6	10,5	10,2	10,1	9,94	9,8	9,65	9,54	9,22	9,12	8,81	8,6	8,26	7,99	7,53	7,2	6,82	6,45
V5	10,4	11,1	11,3	11,1	10,9	10,8	10,7	10,7	10,6	10,5	10,4	10,3	10,2	10	9,94	9,87	9,78	9,59	9,4	9,15	8,63	8,22	7,75	7,28	6,98
V6	10,5	11,2	11,4	11,2	11,1	11,1	10,9	10,7	10,5	10,4	10,1	10,1	10	10	9,82	9,72	9,39	9,12	8,78	8,55	8,19	7,93	7,58	7,26	6,81
V7	9,94	10,8	10,8	10,7	10,8	10,9	10,8	10,8	10,7	10,7	10,6	10,4	10,3	10,2	10,1	9,86	9,53	9,36	9,1	8,84	8,51	8,23	7,83	7,45	7,08
V8	9,93	10,8	11	10,8	10,8	10,9	10,8	10,6	10,4	10,3	10,1	10	9,91	9,88	9,7	9,5	9,26	9,03	8,78	8,48	8,2	7,88	7,53	7,14	6,94

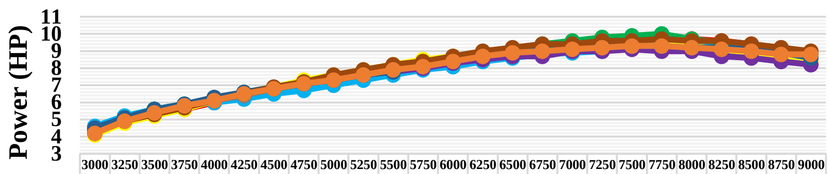
Figure 3. Torque Testing Analysis of Standard and *Turbo Insulator* Variations

Based on Figure 4.1 shows that the standard conditions and the use of *turbo insulators* on Suzuki Shogun NR-125 CC motorcycles reach maximum torque in the range of 3,250 - 4,250 rpm. The use of *turbo insulators* can also increase torque seen in Figure 4. that of the eight variations of *turbo insulator* designs there are seven designs that have increased when compared to the standard, namely in V-1 (11.44 Nm / 3,250 rpm) increased by 0.56 Nm, V-3 (10.94 Nm / 4.250 rpm) increased by 0.06 Nm, V-4 (11.15 Nm/3,500 rpm) increased by 0.27 Nm, V-5 (11.27 Nm/3,500 rpm) increased by 0.39 Nm, V-6 (11.37 Nm/3,500 rpm) increased by 0.49 Nm, V-6 (10.89 Nm/4,250 rpm) increased by 0.01 Nm and V-8 (10.97 Nm/3,500 rpm) increased by 0.09 Nm. The highest increase in torque occurred in V-1, which was 11.44 Nm at 3,250 rpm, 0.56 Nm higher than the standard, while the smallest increase occurred in V-7, which was 10.89 Nm at 4,250 rpm, 0.01 Nm higher than the standard. Meanwhile, one *turbo insulator* design experienced a decrease in torque, namely at V-2 (10.75 Nm/3,500 rpm) decreased by 0.13 Nm compared to the standard.

B. Engine Power Testing Analysis

The analysis of Suzuki Shogun NR-125 CC motorcycle power testing under standard conditions and *turbo insulator* installation is shown in Figure 4 below. Based on Figure 4. shows that the standard conditions and the use of *turbo insulators* on Suzuki Shogun NR-125 CC motorcycles reach maximum power in the range of 7,500 - 8,250 rpm. The use of *turbo insulators* can also increase power seen in Figure 4. that of the eight variations of *turbo insulator* design there is one design that has increased. The increase in power occurs in V-5 which is 10 HP at 7,750 rpm, 0.3 HP higher than the standard. Then one *turbo insulator* design, namely V-7, gets the same power results as the standard condition, which is 9.7 HP at 7,750 rpm. While the six *turbo insulator* design variations experienced a decrease in power when compared to the standard, namely in V-1 (9.3 HP/8,250 rpm) decreased 0.4 HP, V-2 (9.4 HP/7,500 rpm) decreased 0.3 HP, V-3 (9.4 HP/7,750 rpm) decreased 0.3

HP, V-4 (9.1 HP/7,500 rpm) decreased 0.6 HP, V-6 (9.3 HP/7,750 rpm) decreased 0.4 HP, and V-8 (9.3 HP / 7,750 rpm) decreased 0.4 HP.

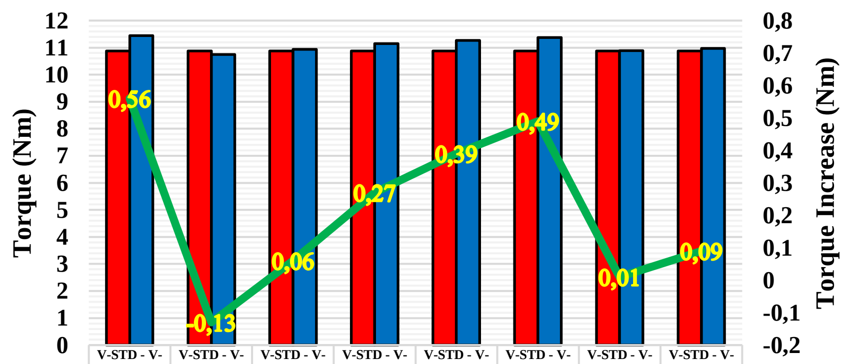


	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000	6250	6500	6750	7000	7250	7500	7750	8000	8250	8500	8750	9000
V-STD	4,3	5	5,4	5,6	6	6,3	6,6	6,9	7,2	7,5	7,8	8,1	8,4	8,8	9,1	9,3	9,5	9,7	9,7	9,7	9,7	9,6	9,4	9,1	8,9
V1	4,6	5,2	5,6	5,8	6	6,2	6,5	6,7	7	7,3	7,6	7,9	8,1	8,4	8,6	8,8	8,9	9	9,2	9,3	9,3	9,3	9,1	8,9	8,7
V2	4,2	4,9	5,3	5,7	6,1	6,4	6,8	7,1	7,3	7,7	8	8,2	8,4	8,7	9	9	9,3	9,3	9,4	9,3	9,2	9	8,7	8,6	8,4
V3	4,1	4,8	5,2	5,6	6,1	6,6	6,9	7,3	7,6	7,9	8,2	8,5	8,7	8,9	9	9,2	9,3	9,4	9,4	9,4	9,3	9,1	8,9	8,6	8,4
V4	4,5	5,1	5,5	5,8	6,1	6,5	6,8	7,1	7,3	7,6	7,8	8	8,3	8,5	8,7	8,7	9	9	9,1	9	9	8,7	8,6	8,4	8,2
V5	4,4	5,1	5,6	5,9	6,1	6,5	6,8	7,1	7,5	7,7	8,1	8,3	8,6	8,8	9,1	9,4	9,6	9,8	9,9	10	9,7	9,5	9,3	9	8,8
V6	4,5	5,1	5,6	5,9	6,3	6,6	6,9	7,2	7,4	7,6	7,8	8,2	8,5	8,8	9	9,3	9,3	9,3	9,3	9,3	9,2	9,2	9,1	8,9	8,6
V7	4,2	4,9	5,3	5,7	6,1	6,5	6,9	7,2	7,6	7,9	8,2	8,4	8,7	9	9,2	9,4	9,4	9,6	9,6	9,7	9,6	9,6	9,4	9,2	9
V8	4,2	4,9	5,4	5,8	6,1	6,5	6,8	7,1	7,3	7,6	7,9	8,1	8,4	8,7	8,9	9	9,1	9,2	9,3	9,3	9,2	9,1	9	8,8	8,8

Figure 4. Power Testing Analysis of Standard and *Turbo Insulator* Variations

C. Comparative Analysis of Maximum Engine Performance

Comparative analysis of maximum engine performance under standard conditions and the use of *turbo insulators* on Suzuki Shogun NR-125 CC motorbikes consists of a comparison of maximum torque and power. Comparative analysis of maximum torque under standard conditions and the use of *turbo insulators* is in Figure 5. below.



	V-STD - V-1	V-STD - V-2	V-STD - V-3	V-STD - V-4	V-STD - V-5	V-STD - V-6	V-STD - V-7	V-STD - V-8
V-STD	10,88	10,88	10,88	10,88	10,88	10,88	10,88	10,88
V-1 - V-8	11,44	10,75	10,94	11,15	11,27	11,37	10,89	10,97
N/T	0,56	-0,13	0,06	0,27	0,39	0,49	0,01	0,09

Figure 5 Comparative Analysis of Maximum Torque

Based on Figure 5, it shows that *turbo insulator* V-1 (5 *blade*, 45°, 4 mm) has the largest torque peak of 11.44 Nm at 3,250 rpm which is 0.56 Nm higher than the standard. *Turbo insulator* V-6 (5 *blade*, 60°, 8 mm) has the second largest torque peak of 11.37 Nm at 3,500 rpm higher by 0.49 Nm than the standard and followed by *turbo insulator* V-5 (5 *blade*, 45°, 8 mm) which has the third

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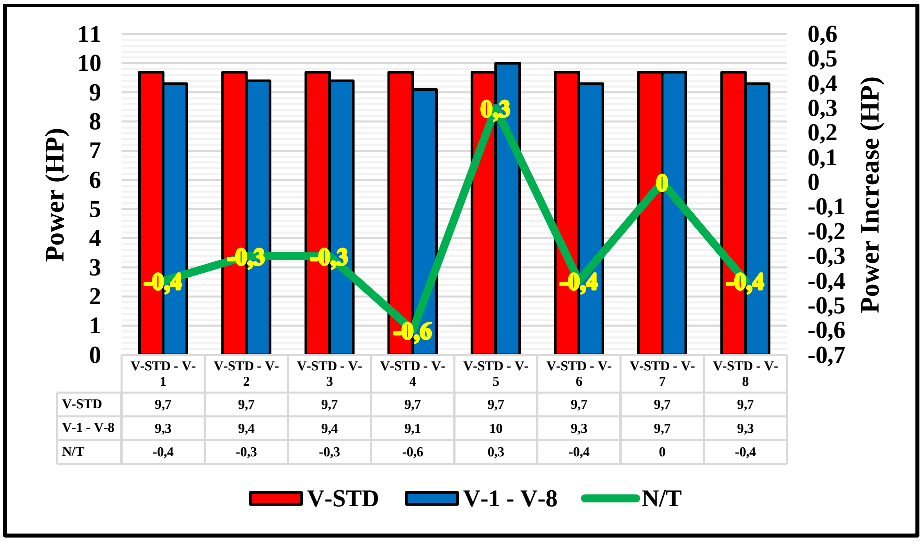
largest torque peak of 11.27 Nm at 3,500 rpm higher by 0.39 Nm than the standard. This shows that the use of *turbo insulators* with different design variations in the number of *blades*, *blade* angle slope, and component thickness affects the torque produced at certain engine speeds. This increase in torque is due to the flow of air and fuel mixture from the carburetor to the combustion chamber becoming turbulent or swirling after passing through the *turbo insulator*, so that the air and fuel mixture becomes more homogeneous and combustion becomes more perfect (Cahyadi et al., 2022; Saka et al., 2018).

Furthermore, a comparative analysis of maximum power under standard conditions and the use of *turbo insulators* is contained in Figure 6 below.



	V-STD - V-1	V-STD - V-2	V-STD - V-3	V-STD - V-4	V-STD - V-5	V-STD - V-6	V-STD - V-7	V-STD - V-8
V-STD	9,7	9,7	9,7	9,7	9,7	9,7	9,7	9,7
V-1 - V-8	9,3	9,4	9,4	9,1	10	9,3	9,7	9,3
N/T	-0,4	-0,3	-0,3	-0,6	0,3	-0,4	0	-0,4

Figure 6: Comparative Analysis of Maximum Power

Based on Figure 6. shows that *turbo insulator* V-5 (5 blades, 45°, 8 mm) has the greatest peak power of 10 HP at 7,750 rpm. This shows that the use of *turbo insulators* with different design variations in the number of *blades*, *blade* angle slope, and component thickness affects the power generated at certain engine speeds. This increase in power is due to the flow of air and fuel mixture from the carburetor to the combustion chamber becoming turbulent or swirling after passing through the *turbo insulator*, so that the air and fuel mixture becomes more homogeneous and combustion becomes more perfect (Cahyadi et al., 2022; Saka et al., 2018). Meanwhile, of the eight *turbo insulator* designs, there is one design that does not experience an increase or decrease in power and there are six designs that experience a decrease in power. This decrease in power is due to the other hand with the *blade* on the *turbo insulator* causing the *inlate* dimensions on the *intake manofold* to be smaller, so that the volume of air and fuel mixture entering the combustion chamber is reduced (Cahyadi et al., 2022; Saka et al., 2018).

D. *Turbo Insulator* Design Optimizes Engine Performance

The most optimal *turbo insulator* design in improving engine performance from the torque and power generated on the Suzuki Shogun NR-125 CC motorcycle is shown in Figure 7 below. Based on Figure 7. shows that the *turbo insulator* V-1 (5 *blade*, 45°, 4 mm) is the design with the highest increase in torque of 11.44 Nm at 3,250 rpm, an increase of 0.56 Nm compared to the standard. Then *turbo insulator* V-6 (5 *blade*, 60°, 8 mm) and V-5 (5 *blade*, 45°, 8 mm), the torque was 11, 37 Nm at 3,500 rpm and 11.27 at 3,500 rpm respectively with an increase of 0.49 Nm and 0.39 Nm compared

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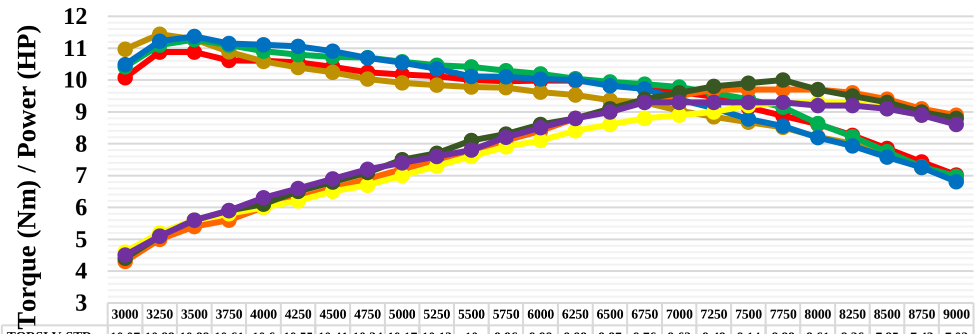
to the standard. From the analysis, *turbo insulator* V-1 with the number of *blades* 5, *blade* angle inclination 45°, and thickness 4 mm is the best design in increasing engine torque.



	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000	6250	6500	6750	7000	7250	7500	7750	8000	8250	8500	8750	9000
TORSI V-STD	10,07	10,88	10,88	10,61	10,6	10,55	10,41	10,24	10,17	10,12	10	9,96	9,98	9,98	9,87	9,76	9,62	9,48	9,14	8,88	8,61	8,26	7,85	7,43	7,02
TORSI V-1	10,97	11,44	11,28	10,89	10,58	10,39	10,24	10,03	9,91	9,84	9,78	9,76	9,62	9,53	9,37	9,3	9,04	8,85	8,68	8,51	8,21	8	7,63	7,25	6,9
TORSI V-5	10,41	11,1	11,27	11,1	10,91	10,8	10,73	10,7	10,57	10,46	10,41	10,29	10,19	10,04	9,94	9,87	9,78	9,59	9,4	9,15	8,63	8,22	7,75	7,28	6,98
TORSI V-6	10,48	11,22	11,37	11,15	11,11	11,06	10,91	10,69	10,54	10,35	10,11	10,1	10,03	10	9,82	9,72	9,39	9,12	8,78	8,55	8,19	7,93	7,58	7,26	6,81
POWER V-STD	4,3	5	5,4	5,6	6	6,3	6,6	6,9	7,2	7,5	7,8	8,1	8,4	8,8	9,1	9,3	9,5	9,7	9,7	9,7	9,7	9,6	9,4	9,1	8,9
POWER V-1	4,6	5,2	5,6	5,8	6	6,2	6,5	6,7	7	7,3	7,6	7,9	8,1	8,4	8,6	8,8	8,9	9	9,2	9,3	9,3	9,3	9,1	8,9	8,7
POWER V-5	4,4	5,1	5,6	5,9	6,1	6,5	6,8	7,1	7,5	7,7	8,1	8,3	8,6	8,8	9,1	9,4	9,6	9,8	9,9	10	9,7	9,5	9,3	9	8,8
POWER V-6	4,5	5,1	5,6	5,9	6,3	6,6	6,9	7,2	7,4	7,6	7,8	8,2	8,5	8,8	9	9,3	9,3	9,3	9,3	9,3	9,2	9,2	9,1	8,9	8,6

Figure 7. Optimal *Turbo Insulator* Design on Engine Performance

Meanwhile, from the power test results, *turbo insulator* V-5 (5 *blades*, 45°, 8 mm) became the design with the highest power increase of 10 HP at 7,750 rpm, an increase of 0.3 HP compared to the standard. Then *turbo insulator* V-1 (5 *blade*, 45°, 4 mm) and V-6 (5 *blade*, 60°, 8 mm) produce the same power of 9.3 HP at 8,250 rpm and 7,750 rpm respectively decreasing 0.4 Hp compared to the standard. From the analysis, *turbo insulator* V-5 with the number of *blades* 5, blade angle inclination 45°, and thickness 8 mm is the best design in increasing engine power.

The most optimal *turbo insulator* design in improving engine performance based on the results of torque and power analysis, the V-5 *turbo insulator* design is the most optimal design. *Turbo insulator* V-5 with the number of *blades* 5, *blade* angle slope 45°, and thickness of 8 mm produces the highest torque of 11.27 at 3,500 rpm and the highest power of 10 HP at 7,750 rpm increasing 0.39 Nm and 0.3 HP compared to the standard.

5. CONCLUSIONS

This study investigated the effects of turbo insulator designs on the intake manifold performance of the Suzuki Shogun NR-125 CC motorcycle engine. The experimental results demonstrated that the most optimal configuration was the V-5 turbo insulator, which featured five blades, a blade tilt angle of 45°, and a component thickness of 8 mm. This design achieved the highest torque of 11.27 Nm at 3,500 rpm and the maximum power output of 10 HP at 7,750 rpm, representing respective increases of 0.39 Nm and 0.3 HP compared to the standard configuration.

Although the improvements in engine performance were relatively modest, the use of turbo insulators consistently contributed to enhanced torque and power outputs across different designs. The V-1 model exhibited the highest torque gain, reaching 11.44 Nm at 3,250 rpm—an increase of 0.56 Nm over the baseline. Meanwhile, the V-5 design showed the most significant power increase.

The findings imply that turbo insulators represent a simple and cost-effective method for achieving incremental performance gains without major engine modifications. These results are particularly relevant for applications requiring affordable performance optimization in small motorcycle engines.

Future research is recommended to explore the long-term durability and reliability of turbo insulator installations under varied operating conditions. Further investigations should also consider the influence of different materials, blade geometries, and combined intake enhancements on overall engine efficiency and emissions performance. Additionally, numerical simulations could be utilized to better understand airflow dynamics and to optimize the insulator design for broader engine types and operational ranges.

6. REFERENCE

Aadepu, S., Prasanth, R., & Naik, J. M. (2014). Design of Intake Manifold of IC Engines with Improved Volumetric Efficiency. *International Journal & Magazine of Engineering, Technology, Management and Research*, *1*(6), 26–33. http://www.yuvaengineers.com/Journal/

Adithya, K., Ahmed, F., Padmanathan, P., Mohan, C. G., & Prakash, R. (2020). Design Optimization of Intake Manifold of Dual Fuel Engine. *Materials Today: Proceedings*, *45*, 646–651. https://doi.org/10.1016/j.matpr.2020.02.726

Alexander, B., & Ruhyat, N. (2024). Pengaruh Panjang Intake Manifold terhadap Performa Mesin Sepeda Motor Injeksi 108 CC. *Jurnal Tugas Akhir Mahasiswa (JTAM) ROTARY*, *6*(2), 159–170. https://doi.org/10.20527/jtamrotaryv7ì1.216

Al-Kayiem, H. H., Wahhab, H. A. A., & Aziz, A. R. A. (2017). Computational Analysis of Flow Characteristic in Inlet and Exhaust Manifolds of Single Cylinder Spark Ignition Engine. *Asian Journal of Applied Sciences*, *10*(3), 102–115. https://doi.org/10.3923/ajaps.2017.102.115

Badan Pusat Statistik. (2024). *Jumlah Kendaraan Bermotor Menurut Provinsi dan Jenis Kendaraan (Unit)*. https://www.bps.go.id/id/statistics-table/3/VjJ3NGRGa3dkRk5MTlU1bVNFOTVVbmQyVURSTVFUMDkjMw==/jumlah-kendaraan-bermotor-menurut-provinsi-dan-jenis-kendaraan--unit---2022.html?year=2023

Badr, A. R., Albahadili, S. F., & Jabbar, T. A. (2022). Experimental and Theoretical Study to Improve the Spark Ignition Engine Performance. *Proceedings of 2nd International Multi-Disciplinary Conference Theme: Integrated Sciences and Technologies, IMDC-IST 2021, 7-9 September 2021*, 1–10. https://doi.org/10.4108/eai.7-9-2021.2314807

Cahyadi, W. R., Ariyanto, S. R., Ardiyanta, A. S., Soeryanto, Nugraha, A. S., & Pratama, M. Y. (2022). Efektivitas Penggunaan Jet Ranger pada Intake Manifold terhadap Performa Honda Vario 150 CC. *Jurnal METTEK: Jurnal Ilmiah Nasional Dalam Bidang Ilmu Teknik Mesin*, *8*(2), 138–145. https://doi.org/10.24843/mettek.2022.v08.i02.p08

Çeper, B. A., Yildiz, M., Demirtas, V., Soyhan, H. S., & Kahraman, N. (2016). 3D Cold Follow Simulation Inside Intake Manifold and Cylinder of an IC Engine. *Journal of FCE - Scientific Paper*, *4*, 44–48. https://dergipark.org.tr/en/download/article-file/303218

Demir, U., Cetinkaya, O., Turkmen, A. C., & Celik, C. (2022). Experimental Investigation of Intake Manifold Design Effect on Diesel Engine Performance. *International Journal of Automotive Science and Technology*, *6*(2), 127–134. https://doi.org/10.30939/ijastech..1108430

Dziubak, T., & Karczewski, M. (2022). Experimental Study of the Effect of Air Filter Pressure Drop on Internal Combustion Engine Performance. *Energies*, *15*(9), 1–32. https://doi.org/10.3390/en15093285

Faturrochman, M., & Yaasiin, T. H. (2024). Efektivitas Subsidi Kendaraan Listrik terhadap Perkembangan Industri Otomotif dalam Mewujudkan Program Making Indonesia 4.0. *Journal of Environmental Economics and Sustainability*, *1*(3), 1–17. https://doi.org/doi.org/10.47134/jees.v1i3.355

Fauzi, Y. R. (2018). Pengaruh Penambahan Turbo Cyclone Aksial terhadap Aliran dan Performa Motor Bakar. *Turbo : Jurnal Program Studi Teknik Mesin*, *7*(1), 25–31. http://ojs.ummetro.ac.id/index.php/turbo

Hadjkacem, S., Jemni, M. A., & Abid, M. S. (2019). Volumetric Efficiency Optimization of Manifold with Variable Geometry Using Acoustic Vibration for Intake Manifold with Variable Geometry in Case of LPG-Enriched Hydrogen Engine. *Arabian Journal for Science and Engineering*, *44*(2), 731–738. https://doi.org/10.1007/s13369-018-3254-7

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e-ISSN : 2964-2647

Hartanto, S., Ihsan, A. M., & Yuliana, G. C. (2019). Pemanfaatan Bioaditif Serai Wangi-Etanol Pada Kendaraan Roda Dua Berbahan Bakar Pertalite. *Junal Teknik Mesin - ITI*, *3*(2), 35–40.

Ingale, S., & Bajaj, P. S. (2020). Design and Optimization of Intake Manifold in Light Duty Vehicle. *International Research Journal of Engineering and Technology (IRJET)*, *7*(10), 1641–1645. www.irjet.net

Kaplan, C., & Aydogan, H. (2020). Investigation of Intake Manifold Design and Its Effect on Engine Performance. *Renewable Energy Sources Energy Policy and Energy Management*, *1*(2), 29–34. https://dergipark.org.tr/en/download/article-file/1230007

Purnomo, H., Barokah, Kriswanto, Saifudin, I., Darmawan, P. D., & Kusuma, D. D. A. (2024). Uji Ekperimental Performa Mesin Diesel Mengunakan Bahan Bakar Biodiesel B35. *Kalao's Maritime Journal*, *5*(1), 28–37. https://doi.org/10.69754/kalaos.v5i1

Saka, N. A. B., Wigraha, N. A., & Dantes, K. R. (2018). Pengaruh Turbulator Empat Bilah dengan Variasi Kemiringan Sudu Terhadap Torsi, Daya, dan Konsumsi Bahan Bakar pada Sepeda Motor. *JJTM*, *6*(3), 168–175.

Saputra, K. A. I., Dantes, K. R., & Wiratmaja, I. G. (2021). Analisis Pengaruh Variasi Sudut Derajat Primary Pulley terhadap Peningkatan Torsi dan Daya pada Kendaraan dengan Sistem Continuous Variable Transmission. *Jurnal Majamecha*, *3*(2), 112–120. https://doi.org/https://doi.org/10.36815/majamecha.v3i2.1544

Shah, J. V., Patel, P. D., & Jotava, D. J. (2014). Effect of Intake Manifold Inclination on Performance and Emission Parameters of 4-Stroke Single Cylinder C.I. Engine : A Technical Review. *International Journal of Engineering Research & Technology (IJERT)*, *3*(1), 2310–2313. www.ijert.org

Silva, E. A. A., Ochoa, A. A. V., & Henríquez, J. R. (2019). Analysis and Runners Length Optimization of the Intake Manifold of a 4-Cylinder Spark Ignition Engine. *Energy Conversion and Management*, *188*, 310–320. https://doi.org/10.1016/j.enconman.2019.03.065

Singla, S., Sharma, S., & Gangacharyulu, D. (2015). Study of Design Improvement of Intake Manifold of Internal Combustion Engine. *International Journal of Engineering Technology*, *3*, 234–242. www.ijetmas.com

Sunaryo, Irfan, A., Setiyo, M., & Amin, N. (2020). Design and Simulation of Mixer Insulators to Improve Turbulence in Intake Manifold. *Journal of Physics: Conference Series*, *1517*(1), 1–6. https://doi.org/10.1088/1742-6596/1517/1/012009

Tyagi, R. K., Sharma, S. K., Chandra, A., Maheshwari, S., & Goyal, P. (2015). Improved Intake Manifold Design For I.C. Engine Emission Control. *Journal of Engineering Science and Technology*, *10*(9), 1188–1202.

Wahyu, M., Rahmad, H., & Gotama, G. J. (2019). Effect of Cassava Biogasoline on Fuel Consumption and CO Exhaust Emissions. *Automotive Experiences*, *2*(3), 97–103. https://doi.org/10.31603/ae.v2i3.2991