JKIE (Journal Knowledge Industrial Engineering) Vol. 9, No. 3, December 2022, pp.192-198

JKIE

http://jurnal.yudharta.ac.id/v2/index.php/jkie

Journal Knowledge Industrial Engineering

E-ISSN: 2541-4461 | P-ISSN: 2460-0113

Analysis Method Analysis of the Effect of Composite Exhaust Silincer Models Using Banana Stem Fiber on the Engine Power of the Toyota Kijang 7K Car

Aladin Eko P. [a], **Julianus Hutabarat**[b], **Eko Budi S.**[c]
[a,b,c]Department of Industrial Engineering, National Institute of Technology, Malang, Indonesia
[a]Corresponding Autor : aladin.eko.purkuncoro@lecturer.itn.ac.id

Article Info

Article history
Received : October 29, 2022
Revised : November 13, 2022
Accepted : December 19, 2022
Published : December 31, 2022

Keywords:
Exhaust;
Engine;
Composite;
Cylinder;
Power.

Open Accsess license
CC-BY-SA

A B S T R A C T

Along with the development of the technological era, human needs are also increasing. In addition, environmental problems also arise such as air pollution, sound/noise. Composite materials are expected to be used to become exhaust materials, of course as a solution to prove that the composite materials are able to reduce noise. The purpose of this study was to determine the power of exhaust engines made from composite materials, to determine the effect of composite exhaust on the power contained in the car. The data collection method used in this study is the observation method and literature study, namely by testing using a dynamometer and the engine used is the Toyota Kijang 7K type. From the data analysis of the relationship between engine speed (rpm) and engine power (HP), it can be concluded that the higher the rpm used, the more horse power will be affected. The urgency of this research includes making a composite exhaust, conducting power testing using a dynotest, the car that will be used for testing is a Toyota Kijang 7K type composite exhaust, and the cylinder models used are cylinder 1 model, cylinder 2 model, and cylinder model 3.

DOI: https://doi.org/10.35891/jkie.v9i3.3549

1. Introduction

In the current era, technological equipment has been growing and increasing, human needs, both primary and secondary, are also increasing, both equipment in the form of means of information communication technology production. Along with the use of these equipments, environmental problems also arise such as air pollution, sound/noise (Liu et al., 2022; Stadnik et al., 2017). The noise in the muffler comes from the velocity of the exhaust gas entering the exhaust tube through the distribution pipe, always changing according to the level of variation in engine speed. The variable speed of the gas hits the inside of the muffler and the muffler wall. The part that was hit by the gas vibrated, and the vibration spread throughout the muffler wall so that it became a noise(Arjunan & Baroutaji, 2021). The speed of exhaust gas entering the exhaust tube has a relationship to variations in engine speed. If the engine speed is high, then the speed of the exhaust gas entering the exhaust tube is high, the sound that comes out of the muffler is the higher the noise level (Jahanbakhshi et al., 2020; Shao, 2011; Sun & Wang, 2016).

Composite materials are expected to be used to become exhaust materials (Şap et al., 2021; Wang et al., 2021; Yuan et al., 2021), of course as a solution to prove that the composite materials are able to reduce noise. This composite material has become one of the alternative materials used for household appliances, medical equipment, pharmaceutical equipment, and the world of transportation, as well as military and aircraft equipment (Naito, Kitamura, Koike, Kusano, & Kusumoto, 2021; Paronesso & Lignos, 2021; Zielińska et al., 2021). This is because composites have great sound dampening properties, and better vibration properties when compared to metal materials (Kushimoto et al., 2021; Naito, Kitamura, Koike, Kusano, Kusumoto, et al., 2021; Şap et al., 2021).

Banana fronds are an alternative to extracting banana frond fiber which has not been utilized optimally. According to a survey that we know about the availability of banana stem raw materials, they should be used to produce various products with economic value and are environmentally friendly. The banana stems have begun to be used as a planting medium by farmers, but not many people use them. The formulation of the problem in this study is how to use banana stems to determine the effect of composite exhaust on car power.

2. Literature Review

Luthfi Hakim and Fauzi Febrianto (2015) entitled "Physical characteristics of composite boards from banana stem fiber (musa. sp) with alkaline treatment" obtained data that use banana stem fiber as an alternative raw material in the manufacture of composite boards. This alternative raw material is needed by the industrial sector due to limited wood raw materials. This study was to determine the effect of NaOH concentration on the physical properties of the composite board. The physical properties of composite boards consist of density, moisture content, water absorption, and thickness expansion.

Khusnul Khotimah, Susilawati and Harry Soeprianto (2015) entitled "sound absorption properties of Banana Stem Fiber (SBP) - polyester composites" in his research the sound absorption properties of sound absorbing materials made from Banana Stem Fiber (SBP) with a polyester matrix. Sound absorbing materials made with variations in the composition of different volume fractions, the volume fraction ratio of SBP and polyester made is 30%: 70%, 40%: 60% and 50%: 50%.

Noni Nopriantina, Astuti (2013) entitled "The effect of kepok banana (Musa paradisiaca) fiber thickness on the mechanical properties of natural fiber polyester composite materials" In her research, the effect of kepok banana (Musa paradisiaca) fiber thickness on the mechanical properties of natural fiber polyester composite materials . In this study, the hand lay-up method was used for the manufacture of composite specimens with reference to ASTMD-4762 while the characterization of compressive strength refers to ASTM D-695 and tensile strength refers to ASTM D-638 (GALDABINI 1987 series 32558).

3. Methodology

The data collection method used in this study is the operating method and literature study, namely by testing using a dynamometer and the engine used is the Toyota Kijang 7K type.

4. Results and Discussion

A. Engine Power Test Result Data

From the observations made during the exhaust testing process for banana fiber composite exhaust using a dynotest tool with variations in rpm (900, 1500, 2000, 2500, 3000) the following table is made:

Table 1. Exhaust test results data

No	Exhaust Type	Rpm	Torque (Kgm)
1	Exhaust 1	900	11.63
2	Exhaust 1	1500	11.16
3	Exhaust 1	2000	10.3
4	Exhaust 1	2500	13.34
5	Exhaust 1	3000	13.06
6	Exhaust 2	900	12.06
7	Exhaust 2	1500	12.46
8	Exhaust 2	2000	13.06
9	Exhaust 2	2500	10.56
10	Exhaust 2	3000	9.45
11	Exhaust 3	900	12.53
12	Exhaust 3	1500	12.36
13	Exhaust 3	2000	13.40
14	Exhaust 3	2500	14.60
15	Exhaust 3	3000	14.56

Source: Data processing

B. Data Processing of Dynotest Test Results

Exhaust test results data 1

- ✓ At 900 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 900 \times 11.63}{60x\ 76.04}$$

$$= 14.407\ HP$$

- ✓ At 1500 Rpm

$$P = \frac{2\pi \times n \times T}{60x\ 76.04}$$

$$= \frac{2\pi \times 1500 \times 11.16}{60x\ 76.04}$$

$$= 23.042HP$$

- ✓ At 2000 Rpm

$$P = \frac{2\pi \times n \times T}{60x\ 76.04}$$

$$= \frac{2\pi \times 2000 \times 13.06}{60\ x\ 76.04}$$

$$= 35.953HP$$

- ✓ At 2500 Rpm

$$P = \frac{2\pi \times n \times T}{60}\ x\ 76.04$$

$$= \frac{2\pi \times 2500 \times 13.34}{60\ x\ 76.04}$$

P-ISSN: 2460-0113 I JKIE (Journal Knowledge Industrial Engineering) I E-ISSN: 2541-4461
DOI: https://doi.org/10.35891/jkie.v9i3.3549 I Vol. 9, No. 3, December 2022, pp.192-198

$= 45.905 HP$

✓ At 3000 Rpm

$$P = \frac{2\pi \times n \times T}{60x\ 76.04}$$

$$= \frac{2\pi \times 3000 \times 13.06}{60x\ 76.04}$$

$$= 53.930 HP$$

Exhaust test results data 2

✓ At 900 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 900 \times 12.06}{60x\ 76.04}$$

$$= 14.904 HP$$

✓ At 1500 Rpm

$$P = \frac{2\pi \times n \times T}{60x\ 76.04}$$

$$= \frac{2\pi \times 1500 \times\ 12.46}{60\ x\ 76.04}$$

$$= 25.726 HP$$

✓ At 2000 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 2000 \times 10.3}{60x\ 76.04}$$

$$= 28.355 HP$$

✓ At 2500 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 2500 \times 10.565}{60\ x\ 76.04}$$

$$= 36.355 HP$$

✓ At 3000 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$== \frac{2\pi \times 3000 \times\ 9.46}{60\ x\ 76.04}$$

$$= 39.064 HP$$

Exhaust test results data 3

✓ At 900 Rpm

P-ISSN: 2460-0113 I JKIE (Journal Knowledge Industrial Engineering) I E-ISSN: 2541-4461
DOI: https://doi.org/10.35891/jkie.v9i3.3549 I Vol. 9, No. 3, December 2022, pp.192-198

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 900 \times 12.53}{60\ x\ 76.04}$$

$$= 15.522HP$$

✓ At 1500 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 1500 \times 12.36}{60\ x\ 76.04}$$

$$= 25.519HP$$

✓ At 2000 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 2000 \times\ 13.40}{60x\ 76.04}$$

$$= 36{,}889HP$$

✓ At 2500 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

$$= \frac{2\pi \times 2500 \times\ 14.6O}{60\ x\ 76.04}$$

$$= 50.241HP$$

✓ At 3000 Rpm

$$P = \frac{2\pi \times n \times T}{60\ x\ 76.04}$$

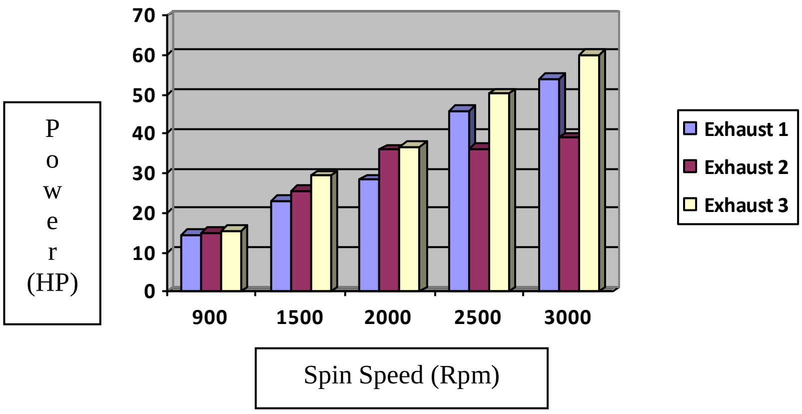
$$== \frac{2\pi \times 3000 \times 14.56}{60\ x\ 76.04} = 60.124HP$$

Table 2. Exhaust test calculation results data

No	Exhaust Type	Rpm	Torque (Kgm)	Power (HP)
1	Exhaust 1	900	11.63	14.402
2		1500	11.16	23.042
3		2000	10.3	28.355
4		2500	13.34	45.905
5		3000	13.06	53.930
6	Exhaust 2	900	12.06	14.904
7		1500	12.46	25.726
8		2000	13.06	35.953
9		2500	10.565	36.355
10		3000	9.46	39.064
11	Exhaust 3	900	12.53	15.522
12		1500	12.36	29.519
13		2000	13.40	36.889
14		2500	14.60	50.241
15		3000	14.56	60.124

From Figure 1. the relationship between engine speed (rpm) and engine power (HP) above, it can be seen that after the dynotest was carried out, for rpm 900 on exhaust 1, the engine power value was 14,402 HP, on exhaust 2, the engine power value was 14,904 HP. on exhaust 3 the engine power value is 15,522 HP, for rpm 1500 on exhaust 1 the engine power value is 23,042 HP, on exhaust 2 the engine power value is 25,726 HP, on exhaust 3 the engine power value is 29,519 HP, for the exhaust 2000 rpm 1 obtained the engine power value of 35,953 HP, on exhaust 2 obtained the engine power value of 28,355 HP on exhaust 3 obtained the engine power value of 36,899 HP, for 2500 rpm on exhaust 1 obtained the engine power value of 45,905 HP, on exhaust 2 obtained the engine power value of 36,355 HP, on exhaust 3 the engine power value is 50,241 HP, for 3000 rpm on exhaust 1 the engine power value is 53,930 HP. , at exhaust 2 the engine power value was obtained at 39,064 HP, at exhaust 3 the engine power value was obtained at 60,124 HP.

Figure 1. Relationship between engine speed (rpm) and engine power (HP)



5. Conclusion

Regarding the relationship between engine speed (rpm) and engine power (HP), it can be concluded that the higher the rpm used, the more horsepower it will have. So the exhaust that has the highest engine power, namely exhaust 3 at 3000 rpm gets an engine power of 60.124 HP. A good cylinder model is the model 3 because the model 3 cylinder has a lot of pores so that the engine power is higher.

References

Arjunan, A., & Baroutaji, A. (2021). Sound pressure level of a Formula 3 car and the influence of detachable muffler-tip. *Results in Engineering*, *11*(July), 100261. https://doi.org/10.1016/j.rineng.2021.100261

Hakim, L., Fauzi F. 2015. *Karakteristik Fisis Papan Komposit Dari Serat Batang Pisang* (*Musa Paradisiaca*).

Jahanbakhshi, A., Yousefi, M., Karami-Boozhani, S., Heidarbeigi, K., & Abbaspour-Gilandeh, Y. (2020). The effect of combined resistance muffler on noise pollution and the allowable driver exposure in Massey-Ferguson tractors (MF 285 and MF 299). *Journal of the Saudi Society of Agricultural Sciences*, *19*(6), 409–414. https://doi.org/10.1016/j.jssas.2020.06.002

Khotimah K., dkk. 2014. *Komposit Serat Batang Pisang* (SBP) – *Epoksi Sebagai Bahan Penyerap Bunyi*.

Kushimoto, K., Moriyama, M., Shimosaka, A., Shirakawa, Y., Hidaka, J., Ishihara, S., & Kano, J. (2021). Measurement method for dispersion states of filler particles in particulate composite materials by macroscopic permittivity. *Advanced Powder Technology*, *32*(1), 272–282. https://doi.org/10.1016/j.apt.2020.12.003

Liu, X., Xu, S. J., Su, C. Q., Yuan, X. H., & Wang, Y. P. (2022). Research on characteristics of thermoelectric generator with integrated muffler and catalytic converter. *Energy Reports*, *8*, 510–

519. https://doi.org/10.1016/j.egyr.2021.11.120

Naito, M., Kitamura, H., Koike, M., Kusano, H., & Kusumoto, T. (2021). *Life Sciences in Space Research Applicability of composite materials for space radiation shielding of spacecraft*. *31*(August), 71–79.

Naito, M., Kitamura, H., Koike, M., Kusano, H., Kusumoto, T., Uchihori, Y., Endo, T., Hagiwara, Y., Kiyono, N., Kodama, H., Matsuo, S., Mikoshiba, R., Takami, Y., Yamanaka, M., Akiyama, H., Nishimura, W., & Kodaira, S. (2021). Applicability of composite materials for space radiation shielding of spacecraft. *Life Sciences in Space Research*, *31*(August), 71–79. https://doi.org/10.1016/j.lssr.2021.08.004

Noni, N. 2013. *Pengaruh Ketebalan Serat Pelepah Pisang Kepok (Musa Paradisiaca) terhadap Sifat Mekanik Material Komposit Poliester-Serat Alam*. Jurnal Fisika Unand Vol. 2, No. 3 ISSN 2302-8491.

Paronesso, M., & Lignos, D. G. (2021). Experimental study of sliding friction damper with composite materials for earthquake resistant structures. *Engineering Structures*, *248*(July). https://doi.org/10.1016/j.engstruct.2021.113063

Şap, S., Uzun, M., Usca, Ü. A., Pimenov, D. Y., Giasin, K., & Wojciechowski, S. (2021). Investigation on microstructure, mechanical, and tribological performance of Cu base hybrid composite materials. *Journal of Materials Research and Technology*, *15*, 6990–7003. https://doi.org/10.1016/j.jmrt.2021.11.114

Shao, Y. L. (2011). A study on exhaust muffler using a mixture of counter-phase counteract and split-gas rushing. *Procedia Engineering*, *15*, 4409–4413. https://doi.org/10.1016/j.proeng.2011.08.828

Stadnik, D. M., Igolkin, A. A., Sverbilov, V. Y., & Afanasev, K. M. (2017). The Muffler Performance Effect on Pressure Reducing Valve Dynamics. *Procedia Engineering*, *176*, 706–717. https://doi.org/10.1016/j.proeng.2017.02.316

Sun, X., & Wang, F. (2016). Investigation on Impedance Chip Muffler Performance. *Procedia Engineering*, *146*, 120–127. https://doi.org/10.1016/j.proeng.2016.06.361

Wang, S., Xu, G., Wang, K., Han, B., Wang, Y., Li, L., Ju, D., Chai, M., Zhang, D., & Zhou, W. (2021). *Current Research in Green and Sustainable Chemistry Fabrication and electrochemical performances of SnO 2 @ C composite materials*. *4*(December 2020), 2–9.

Yuan, J., Liu, Z., Pang, J., Wang, Y., Xie, G., Lin, X., Han, L., Lu, W., & Xu, L. (2021). In-situ evaluation of the damaging process of C/SiC composite material bolts under tensile loading. *Composites Part C: Open Access*, *6*. https://doi.org/10.1016/j.jcomc.2021.100196

Zielińska, I., Polak, D., & Szwast, M. (2021). Analysis of the adsorption of selected pharmaceuticals on a composite material PEBAX/GO. *Journal of Water Process Engineering*, *44*. https://doi.org/10.1016/j.jwpe.2021.102272