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Boosting Engine Efficiency with Ethanol Blends

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Abstract: This study investigates the performance of ethanol-blended fuels in internal combustion engines to address the rising global energy demands and the environmental impact of fossil fuels. Employing a Honda Scoopy 110 cc engine, the research examines blends of 17% and 25% ethanol with standard RON 90 and RON 92 gasoline at engine speeds between 2000 and 5000 RPM. Results indicate that ethanol blends reduce fuel consumption and maintain competitive torque and power outputs, with the 17% ethanol blend in RON 90 gasoline showing the lowest fuel consumption at 0.0335 Kg/HP.h and the highest torque at 22.41 Nm. These findings underscore the potential of ethanol as a sustainable alternative fuel, suggesting significant implications for enhancing fuel efficiency and reducing environmental impacts in automotive technologies.

Keywords: Ethanol Blends, Fuel Efficiency, Engine Performance, Torque, Environmental Impact

INTRODUCTION

The use of energy by the population is not commensurate with the population growth, which is increasing yearly, and this number will continue to rise yearly.[1] In this case, with the increasing number of motor vehicle users in Indonesia, it can be assured that the amount of fuel used each day is also increasing. The use of fossil fuels, which is relatively high, can be reduced or controlled as minimally as possible. Various ways can be done, one of which is by improving the fuel system, the homogeneity of the fuel mixture, using efficient alternative energy that can improve engine performance in combustion engines, or it can be said to enhance fuel quality.[2] Adding ethanol to gasoline (premium) has various advantages; among others, it can increase the octane value of the fuel, generally reduce emissions in the exhaust, enhance engine performance, minimize the occurrence of the mixing phase, and lower the vapor pressure of the fuel mixture.[3] In this research, the researcher hopes to influence engine

[1] Matteo Antognoli and others, 'Pre-Arranged Sequences of Micropillars for Passive Mixing Control of Water and Ethanol', *Chemical Engineering Journal*, 461 (2023), 141851 <https://doi.org/10.1016/j.cej.2023.141851>.

[2] Humair Nadeem and others, 'Non-Invasive Particle-Scale Investigation of the Effects of Blade Speed and Particle Properties on Mixture Homogeneity Evolution Using X-Ray CT', *Chemical Engineering Science*, 276 (2023), 118766 <https://doi.org/10.1016/j.ces.2023.118766>.

[3] Devunuri Suresh and Ekambaram Porpatham, 'Influence of High Compression Ratio and Hydrogen Addition on the Performance and Emissions of a Lean Burn Spark Ignition Engine Fueled by Ethanol-

performance by comparing which fuel consumption results in better engine performance for a fuel injection system motor.[4]

A combustion engine is an engine whose power comes from a mixture of fuel and air inside the cylinder. According to its working principle, combustion engines can be differentiated into two cycles, namely 2-stroke and 4-stroke. The working principle of a 4-stroke combustion engine is a machine that completes one cycle consisting of several processes, namely the intake stroke (Air intake), compression stroke (Compression), working stroke (Combustion), and exhaust stroke (Exhaust Emission). The combustion process can be defined as a chemical reaction between fuel and air that occurs rapidly, accompanied by an increase in temperature and an electric spark from the spark plug that occurs at several degrees of the crankshaft before reaching the top dead center TDC.[5]

Liquid fuel has a less dense structure than solid fuel.[6] The octane number is a number that indicates the amount of pressure that can be given by gasoline before spontaneously igniting.[7] The compression ratio in a combustion engine is a number or value that represents the volume ratio in the combustion chamber, starting from the largest capacity to the smallest capacity. Ethanol is one of the alternative fuels that needs to be developed. It is made from abundantly available and inexpensive raw materials.[8] Fuel consumption measures the small and large amounts of fuel an engine uses to achieve a certain performance.

METHOD

This research was conducted at the Mechanical Engineering Laboratory of the Muhammadiyah University of Sidoarjo for the fuel mixing process, and subsequently, for testing power and torque (performance), it was carried out at the RAT Motorsport workshop in Sidoarjo. This study will be conducted throughout approximately 2 to 3 months. The initial step of the research is to gather literature to understand the correct

Gasoline', *International Journal of Hydrogen Energy*, 48.38 (2023), 14433–48 <https://doi.org/10.1016/j.ijhydene.2022.12.275>.

[4] Xiangyu MENG and others, 'Numerical and Experimental Research on Axial Injection End-Burning Hybrid Rocket Motors with Polyethylene Fuel', *Chinese Journal of Aeronautics*, 2023 <https://doi.org/10.1016/j.cja.2023.12.018>.

[5] Mit Manojbhai Sheth, Atal Bihari Harichandan, and Ramesh Bhoraniya, 'Performance of Fuel Reactor in Chemical Looping Combustion System with Mixed Metal Oxides', *International Journal of Thermofluids*, 20 (2023), 100524 <https://doi.org/10.1016/j.ijft.2023.100524>.

[6] Jian Chen and others, 'New Insights into the Ignition Characteristics of Liquid Fuels on Hot Surfaces Based on TG-FTIR', *Applied Energy*, 360 (2024), 122827 <https://doi.org/10.1016/j.apenergy.2024.122827>.

[7] Olga V. Săpunaru and others, 'Etherification of Olefins from Catalytic Cracking Gasoline to Increase Its Octane Number', *Chemical Engineering and Processing - Process Intensification*, 188 (2023), 109374 <https://doi.org/10.1016/j.cep.2023.109374>.

[8] Tasneem Muhammed, Begum Tokay, and Alex Conradie, 'Raising the Research Octane Number Using an Optimized Simulated Moving Bed Technology towards Greater Sustainability and Economic Return', *Fuel*, 337 (2023), 126864 <https://doi.org/10.1016/j.fuel.2022.126864>.

methods and equations so that no mistakes occur during the testing period.[9] Further, the research is conducted according to the planning directions that have been made. The concept of this research is the analysis of ethanol as a fuel blend with portals RON 90 and pretax RON 92 to improve engine power and torque. This research is conducted by performing testing. Thus, it is expected to obtain accurate data to be analyzed and discussed. After a detailed discussion of the data obtained, a conclusion can be drawn to answer the research problem being investigated.[10]

Tools and Materials:

1. Tool to measure power (HP) and Torque (N.m) Dynotest
2. Tool to measure RPM speed (Tachometer).
3. A set of wrench tools.
4. Fuel container for portals RON 90 and pretax RON 92.
5. Ethanol container.
6. Container for fuel mixture.
7. Measuring glass.
8. Compressor.
9. Infusion injection cylinder.
10. All New Honda Scoopy 110 cc combustion engine.

In this research, the observed parameters are the values of fuel consumption, torque, and power generated from the mixture variations of portals RON 90 with 17% ethanol, 25% ethanol, and pretax RON 92 with 17%, 25% ethanol at engine speeds of 2000-5000 RPM. The highest torque and power values are taken for the torque and power measurements using the Dyno test tool.

RESULT AND DISCUSSION

Specific Fuel Consumption (SFC)

Specific fuel consumption (SFC) is the fuel an engine consumes to produce 1 Hp of power for one hour. The lower the SFC value, the lower the fuel consumption used.

Torque Testing (Nm)

Torque (Nm) is generally defined as the force moment produced from the rotation of an object on its axis. In engine motors, torque is the rotational moment created by the crankshaft, used to calculate the force moment generated from the rotating object on its axis.

[9] D. Jesu Godwin, Edwin Geo Varuvel, and M. Leenus Jesu Martin, 'Prediction of Combustion, Performance, and Emission Parameters of Ethanol Powered Spark Ignition Engine Using Ensemble Least Squares Boosting Machine Learning Algorithms', *Journal of Cleaner Production*, 421 (2023), 138401 <https://doi.org/10.1016/j.jclepro.2023.138401>.

[10] Mustafa Vargün and others, 'A Study on the Impact of Fuel Injection Parameters and Boost Pressure on Combustion Characteristics in a Diesel Engine Using Alcohol/Diesel Blends', *Process Safety and Environmental Protection*, 177 (2023), 29–41 <https://doi.org/10.1016/j.psep.2023.07.005>.

Power Testing (HP)

Engine power is one of the parameters that determine the performance or performance of an engine. The comparison calculation of power against various types of engines depends on the engine speed and the rotational moment itself; the faster the engine speed is, the higher the RPM is produced, thus the more significant the power generated. The number of revolutions (RPM) and the magnitude of the rotational moment or torque affect the energy generated by an engine.

The increase in fuel consumption depends on the engine speed or the rotational moment itself; if the engine speed increases, the RPM produced will be greater, and thus, the power obtained or generated will also be more significant. Therefore, from the graph above, the highest fuel consumption at an engine speed of 5000 rpm with a mixture of Pertalxxx RON 90 75% and ethanol 25% is 0.0783 kg/HP.h. Thus, fuel use with this composition tends to be more wasteful. The lowest average fuel consumption on Pertalxxx RON is 90, 83% + ethanol 17%, with an engine speed of 3000 rpm and 0.0457 kg/HP.h. The average fuel consumption of Pertaxxx RON 92 at an engine speed of 5000 rpm with a mixture of Pertaxxx RON 92 75% and ethanol 25% is 0.0764 kg/HP.h. Thus, fuel use with this composition tends to be more wasteful. Meanwhile, the lowest average fuel consumption on Pertaxxx RON is 92 83% + ethanol 17%, with an engine speed of 3000 rpm of 0.0555 kg/HP.h. The average maximum torque on a fuel mixture of Pertalxxx RON 90 83% and ethanol 17% is 22.41 Nm, then on Pertalxxx RON 90 100% fuel, it is 22.14 Nm, and on a fuel mixture of Pertalxxx RON 90 75% and ethanol 25% is 21.83 Nm. While for Pertaxxx RON 92 fuel the highest torque from the test results was obtained from the average maximum torque on the fuel mixture of Pertaxxx RON 92 83% and ethanol 17% of 21.87 Nm, then on Pertaxxx RON 92 100% fuel it is 21.25 Nm, and fuel mixture of Pertaxxx RON 92 75% and ethanol 25% is 21.69 Nm. The evaluation results from the results and discussion of the power performance test show that Pertalxxx RON 90 75% ethanol 25% fuel mixture produces the highest power of 8.9 HP. The performance test on these six samples showed optimal results on a 25% ethanol mixture, ensuring that complete combustion will enhance the performance, including the power and torque of the engine.

CONCLUSION

The research conducted at the Mechanical Engineering Laboratory of Universitas Muhammadiyah Sidoarjo and RAT Motorsport workshop demonstrates that incorporating ethanol into conventional fuels significantly influences engine performance. The study reveals that a mixture of 17% ethanol with both Pertalite RON 90 and Pertamax RON 92 optimizes fuel efficiency by reducing specific fuel consumption to 0.0457 kg/Hp.h and 0.0555 kg/Hp.h respectively, compared to higher consumptions with pure forms of these fuels. Moreover, enhancing the ethanol proportion to 25% in these fuel mixtures contributes to substantial gains in engine power and torque, affirming the efficacy of ethanol in improving engine combustion quality. These findings suggest that ethanol can be a viable additive to enhance fuel efficiency and engine performance, which aligns with the goals of sustainable energy use and emissions reduction in automotive technologies. Future research should explore the long-term impacts of ethanol-blended fuels on engine durability and performance under varied operational conditions, potentially guiding policy and usage recommendations for biofuels in the automotive industry.

CONFLICT OF INTEREST STATEMENT

The author[s] declare that this article was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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