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The Impact of Boron-Enriched Engine Oil on Motor Performance and Environmental Assessment

Idris Cesur[1], Beytullah Eren[*2]

[1]Department of Mechanical Engineering/Faculty of Technology, Sakarya University of Applied Sciences, Türkiye
[2]Department of Environmental Engineering/Faculty of Engineering, Sakarya University, Türkiye

[*](beren@sakarya.edu.tr)

Abstract – This study investigates the impact of incorporating a boron-based additive into engine oils on motor performance and environmental assessment. Engine oil selection plays a critical role in ensuring the efficient operation of internal combustion engines, influencing parameters such as friction, wear, and overall efficiency. Boron-based additives have shown promise in enhancing these aspects. The study involves experimental tests on a dual-cylinder Lombardini gasoline engine, evaluating performance at various speeds. Results indicate a positive influence on engine torque, effective power, specific fuel consumption (SFC), and effective efficiency with adding boron-based additives. While these findings suggest potential benefits, further extensive studies are recommended for broader validation. The insights derived from this analysis serve as a valuable resource for the engine industry, empowering stakeholders to make informed decisions regarding engine oil selection and performance optimization. Moreover, the study contributes to aligning these decisions with environmental sustainability goals, emphasizing the importance of eco-conscious practices within the automotive sector. In conclusion, this research emphasizes the positive effects of boron addition to engine oils, urging careful consideration for optimizing engine performance. The observed improvements underscore the need for integrating environmentally responsible practices in the automotive sector, supporting a more sustainable future.

Keywords – Engine Oil, Boron-Enriched, Additive, Engine Performance

I. INTRODUCTION

Proper oil selection and use are critical for modern internal combustion engines' efficient and reliable operation. Engine oils reduce friction between moving parts, prevent wear, control temperature, and ensure long engine life [1,2]. Therefore, the composition, performance, and potentially added additives of engine oils can significantly impact the engine's overall performance [3,4]. In addition, a good lubricant reduces oil consumption and harmful exhaust emissions. In this way, the role that engines play in the world economy and energy consumption becomes clear. Improvements in engine lubricants will be instrumental in reducing energy consumption and, therefore, reducing harmful emissions to the world [5,6].

Additives are added to engine oils to improve the friction and wear properties of the surface. The nanoparticles in the additives interact with surface layers and worn surfaces to form new compositions on the surface [7,8].

In recent years, much research has been conducted on the effects of special additives added to engine oils on engine performance. These additives are designed to improve the properties and performance of the oil and, in some cases, can improve the engine's overall performance. Studies on adding boron-based additives to engine oils show that these additives positively affect engine performance parameters [9-12].

Durak et al. investigated the addition of boric acid as an additive to lubricating oil. The experiments were carried out in a wear device at different loads and loads. As a result of the study, they observed significant decreases in friction coefficients in all the test results obtained in experiments with boric acid-added lubricating oil mixture [9]. In their study, Duzcukoglu et al. found a decrease in the sliding friction coefficient in the pin-on-disk system operating at different loads and at a certain speed despite the gradually increasing pressure value by means of boric acid present in the film layer in the contact area [10]. Erdemir et al. investigated boron-doped lubricants' friction and wear characteristics in their study. They found that boron-doped lubricants have very good interaction with sliding surfaces to provide low friction and wear [11]. Karabacak investigated the friction characteristics of boron-doped oils. As a result of the study, it was observed that boron compounds reduced the coefficient of friction by 10% to 50% under different experimental conditions [12].

In this article, our objective is to thoroughly examine the impact of incorporating a boron-based additive into engine oils on overall engine performance. we will specifically examine how these additives impact crucial performance parameters, such as effective additive, specific fuel consumption (SFC), and effective efficiency. The insights obtained from this analysis are expected to serve as a critical resource for the engine industry, providing stakeholders with valuable information to make well-informed decisions regarding engine oil selection and performance optimization. Moreover, our findings aim to contribute to aligning these decisions with environmental sustainability goals, emphasizing the significance of adopting eco-conscious practices within the automotive sector.

II. Materials and Method

The fuel evaluation test engine was a dual-cylinder Lombardini gasoline engine. The experimental investigation used six distinct engine speeds: full load and 1400, 1800, 2200, 2600, 3000, and 3400 rpm. The engine used in the studies was run on gasoline, and data was recorded once the engine reached a steady operating condition. Subsequently, the engine oil was mixed with Boron Additive. The engine tests were conducted again with the addition of boron to the engine oil. In Figure 1, the experimental setup is shown.

The engine performance in the test arrangement was measured using a 20kW electric dynamometer. The fuel usage was measured using a mass flow fuel meter. The fuel flow rate at a given moment was measured by placing the fuel tank on a balance with 0.01g precision.

The technical specifications of additive-free oil and Boron additive oil used in the engine are given in Table 1.

Table 1. Oil technical specifications

	Additive	Without additives
Kinematic viscosity, mm^2/s	208	195
Density, g/cm^3	0.896	0.895
Flash point, ^0C	160	170

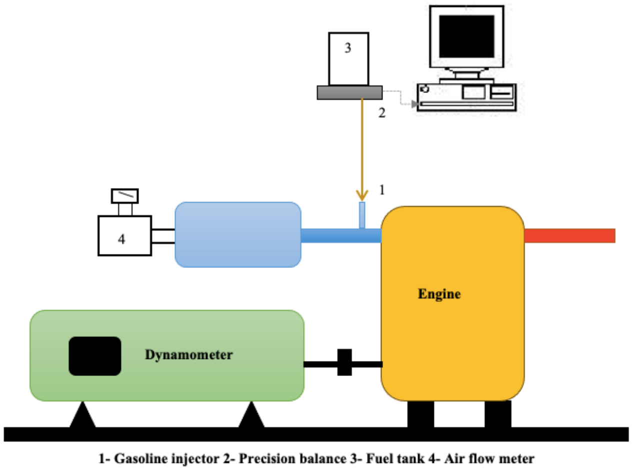

Fig. 1 Schematic view of the experimental setup

III. DISCUSSION

Figure 2 shows the engine torque values obtained with the engine oil without additives and the engine torque values produced by the engine with Boron additive to the engine oil. When the figure is analyzed, it is seen that adding Boron additive to the engine oil causes an increase in engine torque. The maximum increase in engine torque was found to be 3%. The increase in engine torque is thought to be due to the decrease in the friction coefficient between the mechanical parts of the engine with the Boron additive and the decrease in the friction losses of the engine. The decreasing coefficient of friction between the engine parts leads to a decrease in the amount of wear between the engine parts and an increase in engine mechanical efficiency.

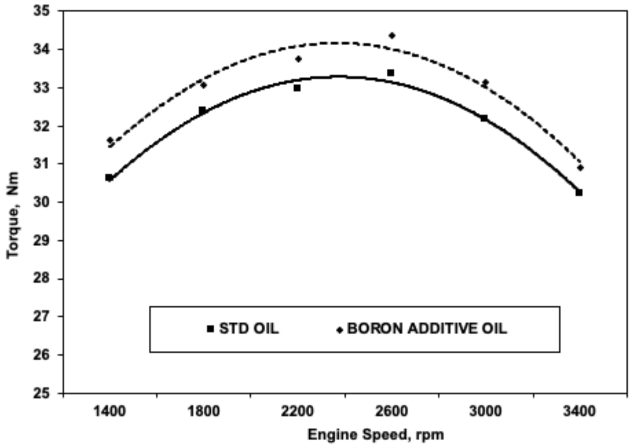

Fig. 2 Torque changes

Figure 3 shows the engine effective power values obtained with the engine oil without additives and the engine effective power values produced by the engine with Boron additive to the engine oil. When the figure is analyzed, it is seen that the addition of Boron additive to the engine oil causes an increase in the amount of effective power. The maximum increase in effective power was determined as 3%. The reason for the increase in effective power with Boron additive is due to the decrease in friction losses and increase in mechanical efficiency with Boron Additive. Increased mechanical efficiency leads to an increase in effective power.

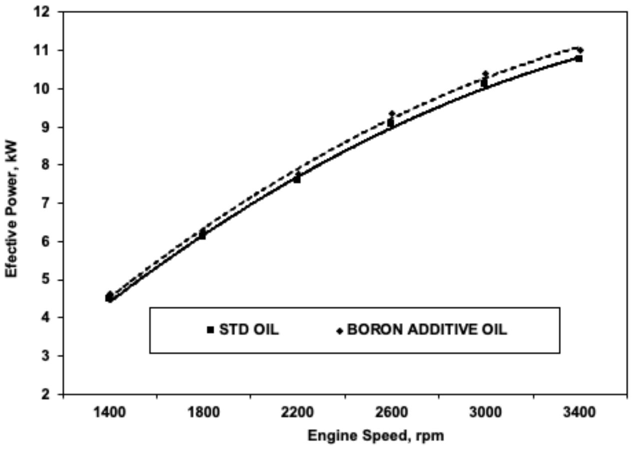

Fig. 3 Effective Power changes

Figure 4 shows the specific fuel consumption values obtained with Boron-added engine oil and Boron-added engine oil. When the figure is analyzed, when Boron additive is added to the engine oil, it causes a decrease in the specific fuel consumption values. The maximum reduction in specific fuel consumption is 2.5% when Boron additive engine oil is used in the engine. The reason for the decrease in specific fuel consumption is the increase in effective power value due to increased mechanical efficiency due to the decreasing friction coefficient with the Boron additive. The decrease in the coefficient of friction in the engine allows more power to be obtained from the fuel.

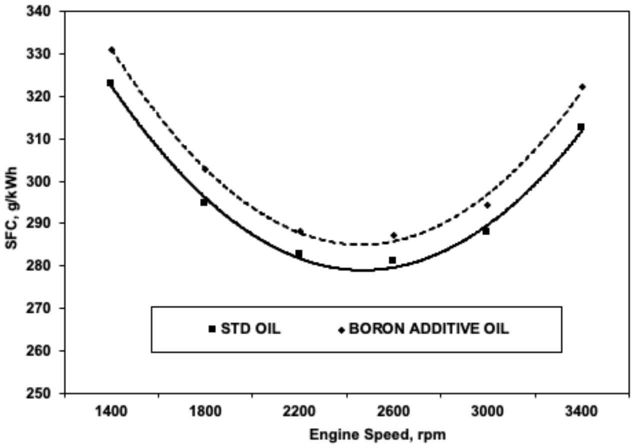

Fig. 4 SFC changes

Figure 5 shows the effective efficiency values obtained with Boron-added engine oil and Boron-added engine oil. When Boron additive is added to the engine oil, it causes an increase in the effective efficiency values. The maximum increase in effective efficiency is 2.7% when Boron-Enriched engine oil is used in the engine. The reason for the increase in effective efficiency is the increase in mechanical efficiency due to the decrease in friction coefficient with Boron-Enriched. Fuel conversion efficiency increases with increased mechanical efficiency. In this way, more effective power value is obtained with the same fuel.

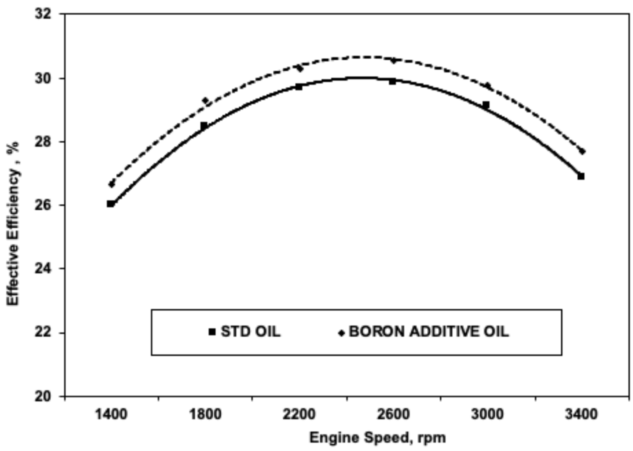

Fig. 5 Effective Efficiency changes

In summary, our findings not only reveal the positive effects of Boron addition on engine performance parameters but also emphasize the potential for these improvements to align with environmental sustainability goals. The observed enhancements in engine efficiency and reduced fuel consumption underscore the significance of adopting eco-conscious practices within the automotive sector. These results contribute valuable insights to guide decisions related to engine oil selection and performance optimization, aligning them with a broader commitment to environmental responsibility in the automotive industry.

IV. CONCLUSION

This study investigated the effects of Boron addition to engine oils has yielded significant insights into engine performance parameters. The critical findings obtained are as follows:

- Boron addition contributes to an increase in effective power. This power increase may lead to improved overall engine efficiency, aligning with efforts to optimize energy use and reduce environmental impact.
- Boron addition enhances engine toughness. Improved engine toughness can contribute to prolonged engine life, reducing the need for frequent replacements and minimizing the environmental impact associated with manufacturing and disposal.
- A significant reduction in specific fuel consumption indicates prolonged engine operation with enhanced energy and fuel efficiency. The observed reduction in fuel consumption aligns with environmental sustainability goals by promoting more efficient fuel use, leading to reduced greenhouse gas emissions and resource consumption.
- Boron addition results in an increase in effective efficiency, extracting more energy from the fuel. Increased effective efficiency signifies a more optimal conversion of fuel into usable power, potentially reducing the overall environmental footprint of engine operations and contributing to energy conservation.

While these results underscore the positive impact of Boron addition on engine oils, it is essential to acknowledge the need for more extensive studies to establish the general validity of these findings. Nonetheless, our conclusion supports the notion that incorporating boron-based additives in engine oils holds the potential to influence engine performance and efficiency positively. Therefore, we recommend carefully considering the potential benefits of boron-based additives in selecting engine oils and optimizing performance.

Furthermore, our findings aim to contribute to aligning these decisions with environmental sustainability goals, emphasizing the importance of adopting eco-conscious practices within the automotive sector. The observed enhancements in engine efficiency and reduced fuel consumption underscore the significance of integrating environmentally responsible approaches into the broader context of engine development and operation. As the automotive industry continues to evolve, embracing such practices will be crucial for meeting environmental standards and fostering a more sustainable future.

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