An Experimental Study On The Effect of Oil Viscosity Variation With Engine Additive On Working Temperature, Viscosity Change and Fuel Consumption of A4-Stroke Gasoline Engine

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Abstract.
This study analyzes the effect of oil viscosity variation with the addition of engine additive on engine working temperature, oil viscosity change, and fuel consumption of a 4-stroke gasoline engine driving a water pump. A quantitative experimental method was applied using SAE 10W-30, SAE 15W-40, and SAE 20W-40 oils combined with 18 mL of Lupromax engine additive. Engine temperature was measured using an infrared thermometer, while oil viscosity at 40°C and 100°C was tested using the Simple Falling Ball Viscometer method, under pump valve openings of 25%, 50%, and 100%. The results show that the additive had a relatively small and inconsistent effect on engine working temperature, but consistently reduced the dynamic viscosity of all oil variations by 6.58-15.06% and lowered fuel consumption across all variations. The combination of SAE 10W-30 oil with 18 mL of additive at a 100% valve opening produced the most efficient performance, with the lowest fuel consumption of 0.24 mL/s. Increasing the valve opening also reduced engine temperature and fuel consumption while significantly increasing pump water discharge. These findings provide practical insight for selecting suitable oil viscosity and additive use in small-capacity 4-stroke gasoline pump engines.
Keywords: *Engine Additive; Engine Working Temperature; Fuel Consumption; Oil Viscosity and SAE Grade.*

I. INTRODUCTION

-capacity 4-stroke gasoline engines are widely used to drive water pumps because of their simple construction, ease of operation, and relatively low maintenance cost. During operation, the main components of the engine, such as the piston, cylinder, valves, and crankshaft, generate friction that produces heat and mechanical energy loss. The lubrication system plays a critical role in reducing friction, maintaining a stable engine working temperature, and supporting fuel efficiency.

approach to improving lubrication performance is by adding an engine additive to the engine oil. Previous studies have reported that additives can reduce oil viscosity, increase engine power and torque, and lower fuel consumption (Senoadi et al., 2019; Sembiring, 2022). In addition, the oil viscosity grade (SAE) also affects engine working temperature and fuel efficiency, with lower-viscosity oils tending to produce more economical fuel consumption (Arya et al., 2024; Pangestu et al., 2024; Surbakti, 2019).

However, most previous studies were conducted on 50-125 cc motorcycles, while research on small-capacity 4-stroke gasoline engines driving water pumps remains limited. Furthermore, few studies have simultaneously analyzed the effects of oil viscosity variation, additive addition, and pump load variation on engine working temperature, oil viscosity, and fuel consumption within a single experimental scheme. Based on this gap, this study aims to analyze the effect of SAE 10W-30, SAE 15W-40, and SAE 20W-40 oil viscosity variations combined with Lupromax engine additive on engine working temperature, oil viscosity change at 40°C and 100°C, and fuel consumption of a 4-stroke gasoline engine driving a water pump, under various pump load conditions (valve openings of 25%, 50%, and 100%).

II. LITERATURE REVIEW

4-stroke gasoline engine is an internal combustion engine that operates through four cycle stages: intake, compression, power, and exhaust. Mechanical interaction between components during these stages generates friction, which can increase engine working temperature and reduce thermal efficiency if not controlled by an adequate lubrication system (Arifin et al., 2021).

Engine oil forms a protective film between two rubbing metal surfaces and also contributes to cooling by absorbing and transferring heat through oil circulation. Oil viscosity grade is classified using the Society of Automotive Engineers (SAE) standard; for example, SAE 10W-30 indicates the oil's ability to work at low (10W) and high (30) temperatures (Wiratno, 2025). As engine working temperature increases, oil viscosity tends to decrease, making the selection of an appropriate SAE grade important for maintaining lubrication performance.

An engine additive is a substance mixed into oil to improve its lubrication characteristics, such as reducing viscosity under certain conditions, lowering friction, and stabilizing the lubricant film. Senoadi et al. (2019) reported that adding an engine additive to SAE 20W-40 oil reduced oil viscosity at 40°C and 100°C, increased engine power and torque, and reduced emissions and fuel consumption. Sembiring (2022) also found that adding an oil additive to a 50 cc 4-stroke engine reduced fuel consumption, with the greatest savings obtained at the highest additive dosage tested.

Regarding the effect of oil viscosity on engine performance, Rahmadi et al. (2025) and Madliyani et al. (2019) showed that oil type and viscosity grade affect motorcycle engine working temperature and fuel consumption. Arya et al. (2024), Pangestu et al. (2024), and Surbakti (2019) consistently reported that lower-viscosity oil (SAE 10W-30) produces more efficient fuel consumption compared to higher-viscosity oil (SAE 20W-40). Meanwhile, Priangkoso et al. (2020) found that higher-viscosity oil tends to lower engine operating temperature but increase fuel consumption, whereas lower-viscosity oil produces more economical fuel consumption despite a relatively higher operating temperature. Oil viscosity in this study was measured using the Simple Falling Ball Viscometer method, a simple technique that calculates the dynamic and kinematic viscosity of oil based on the falling velocity of a test ball in the oil fluid at a given temperature.

Based on this review, oil viscosity variation and engine additive addition are expected to affect engine working temperature, oil viscosity, and fuel consumption; however, studies examining these three parameters simultaneously on a water-pump-driving 4-stroke gasoline engine under varying pump loads remain limited, forming the main focus of this study.

III. RESEARCH METHOD

This study used an experimental research design with a quantitative approach. The research object was a single 7.5 HP 4-stroke gasoline engine driving a water pump, in standard factory condition without modification. The research was conducted on Jalan Kelapasari, Bengkalis, from February to July 2026.

The independent variables included oil viscosity variation (SAE 10W-30, SAE 15W-40, and SAE 20W-40), the addition of Lupromax engine additive (0 mL and 18 mL), and pump operating conditions represented by valve openings (25%, 50%, and 100%). The dependent variables included engine working temperature at the cylinder head, cylinder block, and oil crankcase; the dynamic and kinematic viscosity of the oil at 40°C and 100°C; and fuel consumption. Pump water discharge was measured as a supporting parameter to confirm the pump operating condition at each valve opening. Controlled variables included fuel type (Pertalite RON 90), oil volume, engine warm-up time, testing duration, and the procedures and measuring instruments, all kept consistent across treatments.

Testing was carried out in two stages. The first stage was oil viscosity testing using the Simple Falling Ball Viscometer method at 40°C and 100°C for each oil variation, both without and with additive. The second stage was testing on the water pump engine, operated at valve openings of 25%, 50%, and 100% after a warm-up period of approximately 1 minute. Engine temperature was measured using an infrared thermometer, while fuel consumption was measured using a graduated cylinder over a 15-minute test duration. Each test variation was repeated twice to improve data accuracy. The resulting data were then processed and analyzed descriptively and quantitatively to determine the effect of each independent variable on the dependent variables.

IV. RESULTS AND DISCUSSION

4.1 Effect of Oil Viscosity and Additive Variation on Viscosity

Table 1. Oil dynamic viscosity test results

Oil	Additive	Temp. (°C)	Dynamic Viscosity η (kg/m·s)
SAE 10W-30	0 mL	40	1.9341
SAE 10W-30	18 mL	40	1.8068
SAE 10W-30	0 mL	100	1.5524
SAE 10W-30	18 mL	100	1.3488
SAE 15W-40	0 mL	40	2.0104
SAE 15W-40	18 mL	40	1.8214
SAE 15W-40	0 mL	100	1.5451
SAE 15W-40	18 mL	100	1.3124
SAE 20W-40	0 mL	40	2.3594
SAE 20W-40	18 mL	40	2.0250
SAE 20W-40	0 mL	100	1.6033
SAE 20W-40	18 mL	100	1.4033

Source: Primary test data (2026)

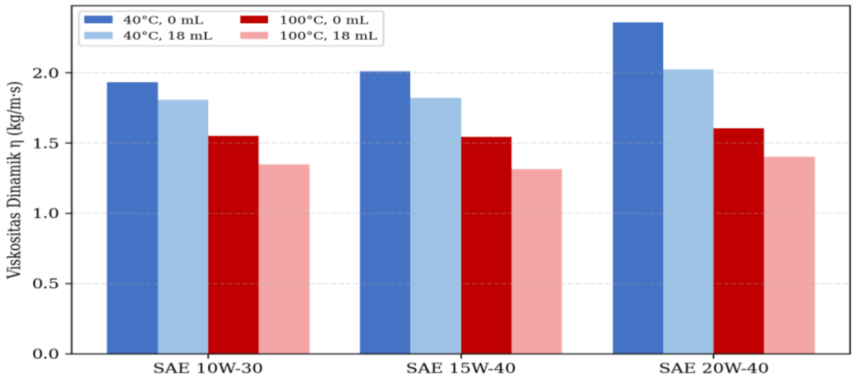

Fig. 1. Comparison of oil dynamic viscosity at 40°C and 100°C, without and with 18 mL additive

Table 1 and Figure 1 show that all oil samples experienced a decrease in dynamic viscosity as temperature increased from 40℃ to 100℃, consistent with lubricant behavior in which higher molecular kinetic energy weakens intermolecular attraction. The addition of 18 mL of additive consistently reduced dynamic viscosity across all three oil types, with reductions ranging from 6.58% (SAE 10W-30 at 40℃) to 15.06% (SAE 15W-40 at 100℃). Nevertheless, SAE grade remained the dominant factor determining viscosity magnitude, with SAE 20W-40 consistently showing the highest viscosity and SAE 10W-30 the lowest across all test conditions.

4.2 Effect of Oil Viscosity and Additive Variation on Engine Working Temperature

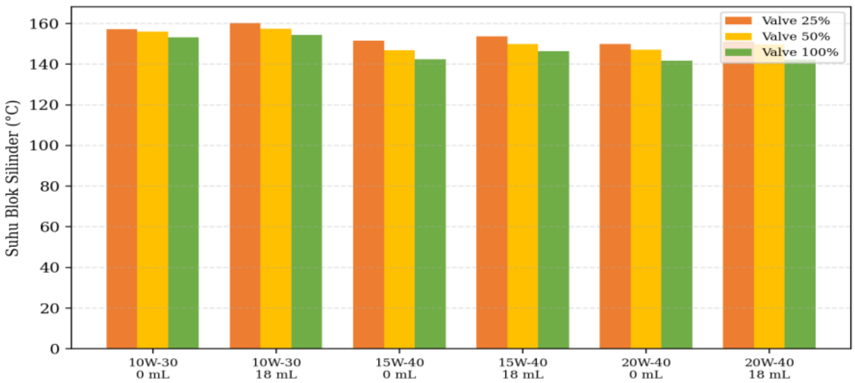

Fig. 2. Cylinder block temperature across oil, additive, and valve-opening variations

Figure 2 and the measurement results showed that the highest temperature consistently occurred at the cylinder block (141.6-160.2℃), followed by the cylinder head (75.8-88.0℃), while the lowest temperature was recorded at the oil crankcase (63.0-67.4℃), since the cylinder block directly receives heat from combustion while the crankcase functions as an oil circulation chamber. The addition of 18 mL of additive did not show a consistent effect on engine working temperature; some oil variations exhibited an increase of about 1-3℃, while others remained relatively stable. Therefore, the additive in this study cannot be concluded as the primary cause of engine temperature change, and appears to play a greater role in maintaining lubrication stability than in directly affecting heat transfer.

4.3 Effect of Oil Viscosity and Additive Variation on Fuel Consumption

Table 2. Fuel consumption rate (mL/s) at various valve openings

Oil	Additive	Valve 25%	Valve 50%	Valve 100%
SAE 10W-30	0 mL	0.30	0.28	0.26
SAE 10W-30	18 mL	0.29	0.27	0.24
SAE 15W-40	0 mL	0.31	0.29	0.27
SAE 15W-40	18 mL	0.30	0.28	0.26
SAE 20W-40	0 mL	0.32	0.31	0.30
SAE 20W-40	18 mL	0.31	0.29	0.29

Source: Primary test data (2026)

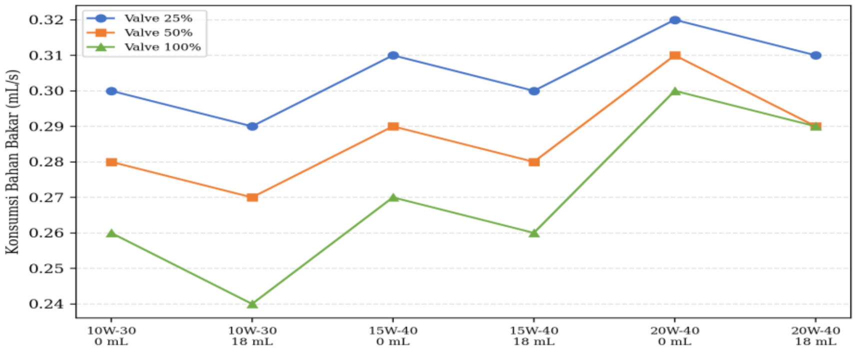

Fig. 3. Fuel consumption rate across oil, additive, and valve-opening variations

Table 2 and Figure 3 show that fuel consumption decreased as the valve opening increased, from a range of 0.29-0.32 mL/s at a 25% opening to 0.24-0.30 mL/s at a 100% opening. The addition of 18 mL of additive reduced fuel consumption across all oil variations, with SAE 10W-30 consistently producing the most economical fuel consumption. The best combination was obtained with SAE 10W-30 oil and 18 mL of additive at a 100% valve opening, yielding the lowest fuel consumption of 0.24 mL/s. This finding indicates that lower-viscosity oil reduces frictional resistance in engine components, allowing the generated energy to be used more efficiently.

4.4 Integrated Discussion

Overall, the four observed parameters (oil viscosity, engine working temperature, fuel consumption, and pump water discharge) are interrelated. Oil with a higher SAE grade has greater viscosity and frictional resistance, consistent with higher fuel consumption and lower pump discharge compared to SAE 10W-30 oil. The addition of 18 mL of engine additive consistently reduced viscosity and fuel consumption while increasing pump water discharge, but did not consistently affect engine working temperature. Variations in pump load through valve opening showed a clear relationship: as the valve opening increased, water discharge increased while engine temperature and fuel consumption tended to decrease, because the engine speed at larger valve openings was lower, reducing frictional load and combustion energy demand per unit time. The combination of SAE 10W-30 oil with 18 mL of additive at a 100% valve opening provided the most optimal overall performance.

These results are consistent with Senoadi et al. (2019), who found that engine additive addition reduces oil viscosity and fuel consumption, and reinforce the findings of Arya et al. (2024), Pangestu et al. (2024), and Surbakti (2019) that SAE 10W-30 oil produces more efficient fuel consumption than SAE 20W-40. However, unlike Priangkoso et al. (2020), who found a clear relationship between oil viscosity and engine operating temperature on motorcycles, this study did not find a consistent relationship between oil viscosity and engine working temperature for a water-pump-driving engine. This discrepancy is likely due to differences in the test object and scheme, as previous studies were largely conducted on 50-125 cc motorcycles under road tests, whereas this study used a stationary gasoline engine driving a water pump under varying valve-opening loads.

V. CONCLUSION AND SUGGESTION

This study concludes that oil viscosity variation combined with engine additive addition has a relatively small and inconsistent effect on engine working temperature, but consistently reduces oil dynamic viscosity by 6.58-15.06% and lowers fuel consumption across all tested oil variations. SAE grade remains the dominant factor determining viscosity and fuel consumption, with SAE 10W-30 oil producing the most efficient performance. Variations in pump load through valve opening also affect engine working temperature, fuel consumption, and water discharge, with the combination of SAE 10W-30 oil and 18 mL of additive at a 100% valve opening providing the most optimal performance, with the lowest fuel consumption of 0.24 mL/s.

For users and technicians of small-capacity 4-stroke gasoline engines driving water pumps, the use of SAE 10W-30 oil combined with an engine additive can be considered a more fuel-efficient option without causing a significant increase in engine working temperature. Future research is recommended to test several additive dosage variations under more controlled environmental conditions, and to include additional parameters such as exhaust emissions and microscopic component wear to obtain a more comprehensive understanding of the effect of engine additives on overall engine performance.

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