Performance and emissions characteristics of n-pentanol mixed with premium motor spirit and camphor blend in spark ignition engine

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ABSTRACT

In this work, pentanol and camphor blended with petrol in different proportions were used on spark-ignition engines to evaluate their performance, characteristics, and emissions. Sample P0A (gasoline) showed the best specific fuel consumption for the lower torque (3Nm) with a value of 19.2Kg/kWh, and sample P0B (100% of pure gasoline and 5% camphor) had the best fuel consumption for the higher torque (6Nm) with a value of 12.9Kg/Kwh. For brake thermal efficiency, sample P0B gives the best brake thermal efficiency at the two-constant torque with a value of 0.34 for torque 3Nm and 0.65 for torque 6Nm respectively. Sample P15A (85% of gasoline and 15% of pentanol) gives the best BMEP at torque 3Nm with a value of 1.97bar and sample P5C (95% of gasoline and15% of pentanol) gives the best BMEP at 6Nm with a value of 3.87 bar.

Keywords: Camphor; gasoline; engine emission; Pentanol; Camphor; engine performances

INTRODUCTION

As poor fuel quality may be measured by engine emission, where these emissions pose a threat to the environment we're living in, different sources of energy are being explored to have a more economical, sustainable manner (Ibrahim et al. 2020). For a peaceful solution, improving the quality of these fossil fuels is considered. Various research groups have investigated various approaches to find or develop a new or improved fuel that will suit and conform to environmental guidelines, which promotes sustaining and maintaining a healthy environment for all.

Nagarajan et al. (2021) investigated the effect of addition of pentanol with Karanja biodiesel The brake thermal efficiency was found to increase, whereas brake specific fuel consumption decreased with an increase in concentration of pentanol. Rangabashiam et al. (2020) investigated the effects of oxygenated additives blends in the diesel engine. A reduction in HC emissions were observed. Rathinam et al. (2019). examined the addition of butanol on the emissions pattern of neat neem oil biodiesel (NBD100) fueled diesel engine. Devaraj et al. (2020) investigated use of dimethyl carbonate (DMC) as an additive. Carbon monoxide (CO) and hydrocarbon (HC) emissions decreased. Ganesan et al. (2020) found that addition of proportion of biodiesel–diesel blend (A20) can substantially reduce emissions. Devarajan et al. (2020) investigated the emission from an engine operated by using neem oil methyl ester (N100) as blends. By doping 20% of pentanol to neem oil biodiesel a reduction in HC and CO was seen.

Researchers have discussed and reported on the use of fuel additives and blending fuels with other fuels, with most findings showing an improvement, leaving room for more research (Prabhu et al. 2019). Despite the increase of 31.8 percent for (BPro20) and 40.9 percent for

(BPen20). This study reveals that greater 1-pentanol blends impair engine performance but reduce NOx emissions by 16.7% for P30D70 mix (Santhosh et al. 2020). With greater alcohol (butanol) (Rathinam et al. 2019) engine emissions of NOx, HC, and CO were dramatically reduced by 6.8%, 10.4%, 8.6%, and 5.9%, respectively. A ternary blend of pentanol/safflower oil biodiesel/diesel fuels was tested for performance, emissions, and combustion properties (Yesilyurt et al., 2020). The results show that ternary mixes have higher BSFC than Petro diesel, but lower NOx emissions. On the other hand, (Rangabashiam et al. 2020) compare the influence of different fuel additives DMC (Di-methyl-carbonate) and Pentanol (n-P) on ignition patterns of biodiesel/diesel blends in the diesel engine and found significant improvements in the performance of the engine, including a reduction in engine brake specific fuel consumption and an increase in engine brake thermal efficiency of 0.3 and 0.6 Using butanol as an oxygenated ingredient to Calophyllum inophyllum (Punnai) biodiesel, Devarajan et al. (2019) found that NOx, CO, and HC emissions were reduced compared to unblended biodiesel. (Atmanli and Yilmaz 2020) found that adding propanol and pentanol to waste oil biodiesel increased brake specific fuel consumption and lowered thermal efficiency (Atabani and AL Kulthoom 2020) Studying the effects of combining fuels with alcohols is necessary, as the results were encouraging (Appavu et al. 2020). The addition of pentanol to diesel and biodiesel reduces engine brake power and torque while improving CO, NOx, and smoke opacity by 41.76 percent, 27.6 percent, and 32.4 percent, respectively. When using Jatropha biodiesel with pentanol. For example, (Devaraj et al. 2020) found that 10% and 20% doping pentanol with cashew nut biodiesel reduced engine emissions relative to pure CNBD. a similar engine pollution reduction result was reported by (Kaisan et al. 2017). (Ibrahim et al., 2020) investigated the effect of combining pentanol in modest percentages with moringa oleifera biodiesel and found that while fuel quality and engine brake power improved, NOx emissions increased. (Elfasakhany 2015) found that blending isobutanol with gasoline lowered engine cylinder pressure, brake power, and exhaust gas temperature compared to pure gasoline. The effects of 1-butanol and 2-propanol combined with rapeseed oil on a diesel engine were studied by (Laza and Bereczky 2009). According to the results, adding butanol reduces NOx emissions while adding 2-propanol increases them. Alcohol blends also lower the diffusion phase time while boosting combustion kinetic intensity. A study by (Elfasakhany and Mahrous 2016) compared the performance of dual n-butanol and iso-butanol additives to a single alcohol blend, and found that a dual alcohol blend has the best engine performance.

Many studies (Kumar et al., 2019) explored the effects of injection pressure on the combustion parameters of a biodiesel engine using cerium oxide nanoparticles as a fuel additive. The researchers discovered that adding cerium oxide nanoparticles to biodiesel enhances engine combustion properties, such as peak pressure and heat release rate. The best engine performance was obtained at 240 bar injection pressure with 80 ppm nanoparticle concentration. The effect of propanol and camphor on spark-ignition engine performance and emissions was examined and compared (Kaisan et al. 2020). It also improves thermal efficiency, particular fuel consumption, and engine brake power. Similar research (Kaisan et al. 2020) reveals that adding 5g of camphor improves both fuel physicochemical qualities and engine performance better than adding butanol, but reduces engine pollution.

The effect of camphor and pentanol as gasoline additives will be studied. Because camphor is widely used in SI engines in Nigeria, but little research has been done on its use as a fuel additive, this study compares the effects of camphor and pentanol on engine performance and emissions to determine which has the potential to improve engine performance.

Camphor is derived from the wood camphor laurel, Cinnamomum camphora, which is native to China and Taiwan. Camphor is an organic substance that is white in color. Camphor is used to cure fungal infections, relieve pain and irritation, and minimize coughing (Hamidpour et al. 2013). Camphor is an organic substance, whitish in color. The engine's performance and emissions will be monitored and studied. Traditionally, truckers add camphor to their gasoline tanks to minimize fuel usage and emissions.

Materials, equipment, and methods

Sample preparation

Camphor was first powdered. Samples P0A-P15B-P15C were prepared for this study. 0g, 5g, and 10g of camphor were added to each of the first three samples. The blends are P0A, P0B, and P0C. The next three samples were filled with 95% petrol and 5% n-pentanol, with 0g, 5g, and 10g of camphor, and labeled P5A, P5B, and P5C. 0g, 5g, and 10g of camphor were added to the samples labeled P10A, P10B, and P10C, respectively as shown in Table 1. Finally, three further samples containing 15% n- pentanol each were created, with 5g and 10g of camphor additions added to two of the mixes, labeled P15B and P15C, respectively.

Table 1. Nomenclature of the samples

S/n	SAMPLE PREPARED	Compositions of samples		
		PMS CONTENT IN THE BLEND %	N-PENTANOL CONTENT IN THE BLED %	CAMPHOR ADDED
1.	P0A	100 .00	-	-
2.	P0B	100. 00	-	5. 00
3.	P0C	100. 00	-	10. 00
4.	P5A	95. 00	5. 00	-
5.	P5B	95. 00	5. 00	5. 00

6.	P5C	95. 00	5. 00	10. 00
7.	P10A	90. 00	10. 00	-
8.	P10B	90. 00	10. 00	5. 00
9.	P10C	90. 00	10. 00	10. 00
10.	P15A	85. 00	15. 00	-
11.	P15B	85. 00	15. 00	5. 00
12.	P15C	85. 00	15. 00	10. 00

Experimental procedure for performance and emission test

The fuel blends were tested on an engine having specifications shown in table 2.The general layout of test engine is shown in figure 1.

Figure 1. E xperimental setup for the performance and emission test analyzer setup

Table 2. Specification of the engine manufactured by T-equipment technology.

Engine type	4-stroke single cylinder engine
Net power	4.5kw at 3600rpm
Weight	27kg
Speed	Approximately 3600rpm
Engine capacity	208cc
Net torque	12.5Nm at 2800rpm

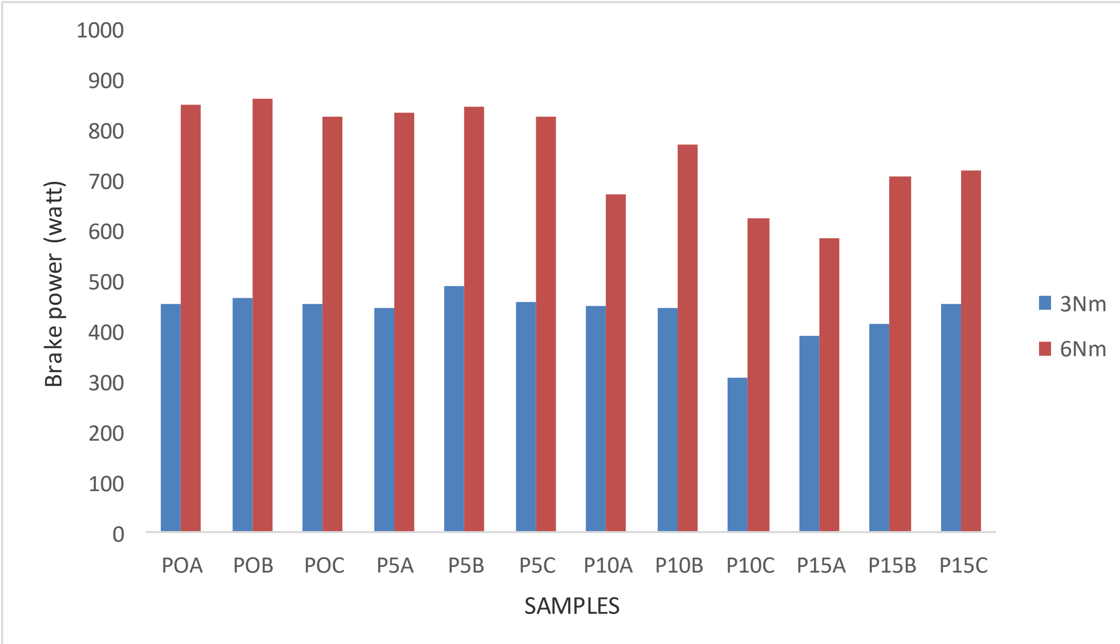

Figure 2. Brake power at 3Nm and 6Nm

The effects of incorporating camphor into gasoline on the engine's brake power are depicted in Figure 2. The addition of camphor alone produces only a slight difference in engine brake power when compared to P0A, but the combination of camphor and pentanol produces a significant difference in engine brake power, but sample P0B at 6Nm produces a significant improvement, with an increase of approximately 1.8 percent recoded, and sample P5B with 5 percent pentanol and 5g of cayenne produces a significant improvement, with an increase of approximately 1.8 percent recoded.

Specific fuel consumption

This is defined as the ratio of the mass flow rate of fuel into the engine-to-engine brake power (Kaisan et al. 2017), the effect of camphor -pentanol blends with gasoline on specific fuel consumption is presented in the figure at both engine Torque of 3Nm and 6Nm

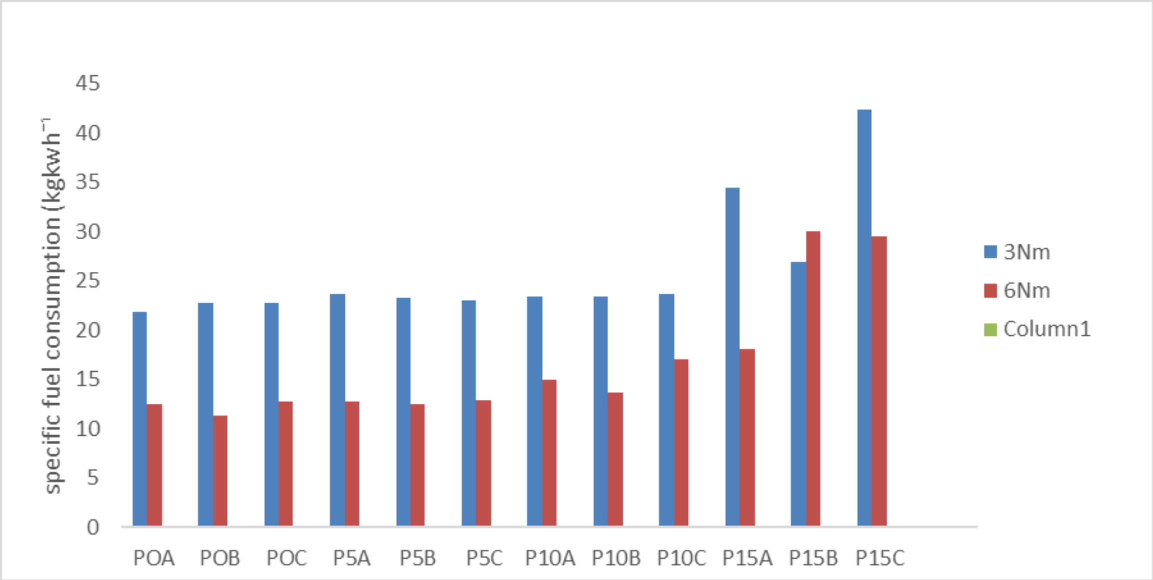

Figure 3. Specific fuel consumption

According to the figure 3, the sample with the lowest specific fuel consumption at 3Nm is petrol (POA), with a value of 19.2kgkwh^{-1}, whereas at 6Nm, the sample with the lowest specific fuel consumption is diesel (POB), with a value of 12.9kgkwh^{-1}. These results demonstrate that the addition of camphor and pentanol increases engine specific fuel consumption, and that this was noticeable at each engine torque, with the highest increase in engine specific fuel consumption recorded by sample P15C, which was approximately 94.3 percent higher when compared to the pure gasoline fuel.

Brake thermal efficiency

A little or no increase in engine brake thermal efficiency was experience at each engine torques tested, with addition of camphor additives to pure petrol but with the addition of pentanol engine brake thermal efficiency reduces significantly at each engine torques tested. the lowest engine brake thermal efficiency is recorded by sample P15B with about 37% reduction as compared to the Pure gasoline fuel, at 6Nmas seen in figure 4.

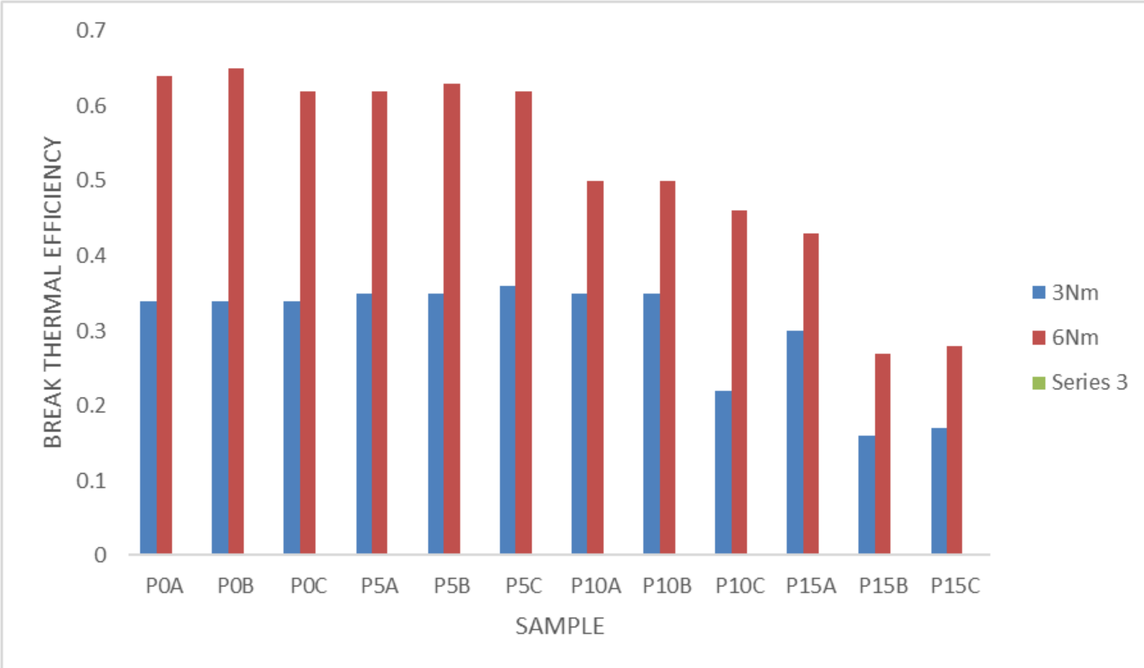

Figure 4. Break thermal efficiency

Brake Mean Effective Pressure (BMEP)

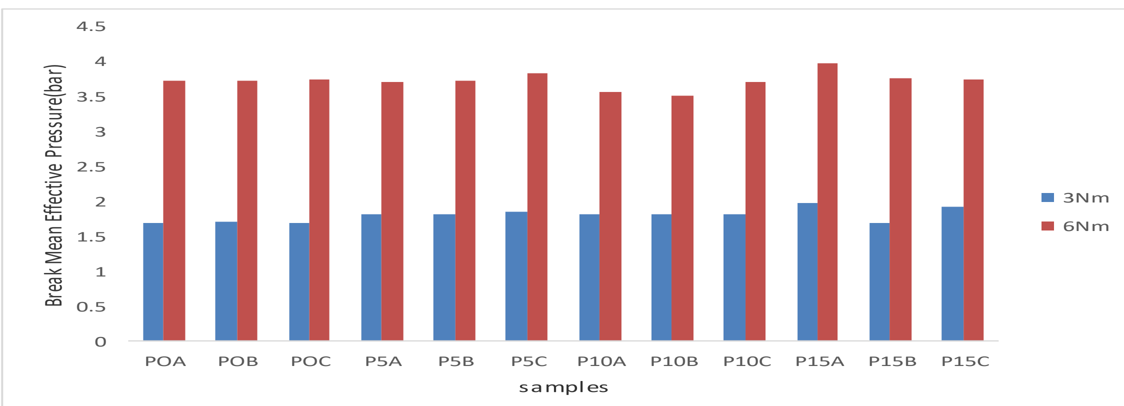

Figure 5. Break mean effective pressure

The figure 5 represented the finding on engine Brake Mean effective pressure (BMEP). Sample P15A shows the highest BMEP at both engine torque of 3Nm and torque 6Nm with a value of and a 3.97 bar. While at 3Nm has a value of 1.97bar. While sample P0B and P0C appeared to have almost the value with the P0A despite having 5g and 10g of camphor added.

Conclusion

From the experimental results presented here, it is concluded that, addition of both camphor and pentanol on conventional gasoline affects the combustion process. The P0B is the best blend in terms of engine performance showing best engine power, and engine brake thermal efficiency. The entire blends performed well in terms of brake mean effective pressure. In general, it was concluded that the addition of pentanol being an oxygenate reduces the engine emissions as compared to pure gasoline. This finding will go a long way in selecting the best blends to use in solving current environmental problem resulting from the use of Petrol.

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