Comparison of camphor and fuel injector cleaner effects on the performance and emissions of gasoline engines

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Muhammad Usman Kaisan[*], Muhammad Kachalla[*], Ibrahim Umar Ibrahim[*], Sunny Narayan[**]

[*] Mechanical Engineering Department

Ahmadu Bello University Zaria

[**] Mechanical engineering department, Qassim University, Saudi Arabia

ABSTRACT

In this research injector, cleaner, and camphor were blended with premium motor spirit (PMS). Physicochemical properties and effects on performance and exhaust emission on spark ignition engines were investigated. Samples with injector cleaner show the best physicochemical properties as compared to the sole petrol and camphor blended samples having a density of 0.72706kg/m2 (I5), a flashpoint of 47oC by sample (I5, I10, I15,) and 48^{o}C by I25, and 1.7 viscosity, performance analysis shows that I25 at 3Nm has a specific fuel consumption of 45.51kgkwh-^{1} and 27.2 kgkwh-^{1} which is best recorded among all the samples, also the sample (I25) has shown the least emission of CO and CO2 with a 0.2% and 0.13% at 3Nm and 6Nm for CO emission and 1.22 and 1.47% for CO_2 at 3Nm and 6 Nm respectively, concerning NOx emissions also sample I25,shows the best result were it reordered highest NOx emission reductions with a value of 312 and 342ppm at 3 and 6 Nm engine torque. with this it was concluded that injector cleaner blends are better as compared with camphor blends.

Keywords: Petrol, Camphor, Emissions, Blends, Physiochemical Properties, Gasoline; injector cleaner.

INTRODUCTION

Improving the quality of fuels has been a subject of research interest by scientists, especially in these recent years, several research work that is aimed at improving both engine performance and reducing Engine emissions are carried out. Some of these research works were specifically carried out to investigate the prospects of blending fuels with some additives or other fuels with similar or improved properties (Ashok, B., Jeevanantham, A. K., Nanthagopal, K., Saravanan, B., Senthil Kumar, M., Johny, A., Mohan, A., Kaisan, M. U., & Abubakar, S. 2019). Kaisan et al. examined and compared the effect of propanol and camphor on spark-ignition engine performance and emissions (Kaisan, M. U., Pam, G. Y., & Kulla, D. M. 2013). Findings showed that Sample P0B (100% of pure gasoline and 5 g of camphor) had the best physicochemical properties. The fuel property of the blend improved by the addition of 5g camphor as an additive. Results showed a percentage increase of 0.5% for specific gravity, 30.8% viscosity, 5.08% fire point, and 21.8%, flashpoint. It also showed improvement in the engine brake thermal efficiency, specific fuel consumptions, and engine brake power. In similar research, Kaisan et al .investigated the effect of camphor and butanol on engine performance and emission (Kaisan, M.U., Sanusi, A., Ibrahim, I. U., & Abubakar, S. 2020). It also shows that the addition of 5g of camphor was the best in improving both the fuel physicochemical properties and engine performance than the addition of butanol, but engine emission reduced with the addition of Butanol.

Higher Alcohol was intensively also put to use in research works, to ascertain their influence, on engine performance and emissions. studied the effects of Iso iso-butanol blended with gasoline, on SI engines. The results showed that Brake power, exhaust gas temperature, and in-cylinder pressure decrease, for blends with 3, 7 and 10 % by volume of iso iso-butanol in gasoline, as compared to pure gasoline without any engine optimizations (Kaisan, M.U., Sanusi, A., Ibrahim, I. U., & Abubakar, S. 2020). They investigated the effect of higher alcohols (1-butanol and 2-propanol) blended with rapeseed oil, on a diesel engine, at a proportion of 10% and 20% to reduce the viscosity. Results showed that both have affected the engine emission, notably, NOx emission had reduced with butanol while increasing with 2-propano. In terms of combustion process results, showed that alcohol blends reduce the length of the diffusion phase while increasing the combustion kinetic Intensity. Kaisan studied the effects of using Dual n-butanol and iso-butanol additives on spark-ignition engine performance and emissions over single alcohol and neat gasoline blends, where n-butanol and iso-butanol were blended with gasoline separately, and another blended with n-butanol and iso-butanol combined blended with gasoline. The results showed that a dual alcohol blend has the best engine performance among all the blends including blends with single alcohol blends. They also, studied the effect of butanol when blended with gasoline in a single-cylinder engine run between a speed of 6500 and 8500rpm. The results showed that the butanol-gasoline blend provided higher knocking resistance by allowing advanced ignition timing in SI engines, which lead to more efficient combustion. It was also found out that blends with a higher percentage of along with optimum spark ignition timing resulted in lower HC, CO, and oxygen (O_2) emissions when compared with blends with no or lower butanol volume percentage, though it was also noticed that NOx and CO_2 emissions were significantly higher for these blends compared to pure gasoline. In terms of basic exhaust gas emissions, ternary blends increased nitric oxide (NO) and carbon monoxide (CO) emissions while reducing hydrocarbon (HC) and carbon dioxide (CO2) emissions as compared to diesel. (Eyidogan et al., 2010) uses ethanol–gasoline (E5, E10) and Methanol – gasoline (M5, M10), fuels blends on SI engine runs at a different vehicle speed of 80 km/h and 100 km/h and compared the results with the gasoline fuels. The results indicated that when alcohol–gasoline fuel blends were used, the brake specific fuel consumption increased and cylinder gas pressure started to rise at almost all test conditions, the lowest peak heat release rate was obtained from the gasoline fuel use. (I. A. Hussain, I. U. Ibrahim, 2020), study the potential of using biodiesel as an alternative fuel, using biodiesel from cottonseed oil, it was observed that Pure diesel was thermally more efficient than biodiesel blends at low torque but biodiesels tend to have higher engine brake power. Using five samples with different compositions of the n-pentanol fraction (10%, 20%, 30%, 40%, and 50%) by volume. Findings showed that brake thermal efficiency has improved by about 30% compared to pure diesel with specific fuel consumption of biodiesel-pentanol blends increased from 4.2% to 27.3%, when compared to diesel fuel (D100).

Metallic additives were also investigated and their influence in improving the fuel quality, engine performances, and Emissions was reported by many research reports. Biodiesels from waste cooking oils were mixed with minerals diesel in proportions of 20:80 with cerium oxides nanoparticles as an additive, findings reveal that nanoparticle addition of cerium oxide (CeO_2) improves engine combustion characteristics, e.g., it leads to higher peak pressure and a higher heat release rate. It was noted that the best engine performance was observed at an injection pressure of 240 bar with an 80-ppm nanoparticle concentration. In terms of emissions hydrocarbon, oxides of nitrogen and smoke decreased at higher injection pressures with nanoparticle addition.

The use of camphor and injector cleaner on SI engines is widely reported by vehicle users especially in Nigeria with a different account of their influence on engine performances, very few researches are available on their use as fuel additives, in this research an effort is made to investigate the effect of both camphor and injector cleaner on engine performance and emission and also compare the two, to ascertain the best that improve the fuel quality, engine performance, and emission.

Sample preparation

Table 1 below shows the composition of various samples of blends.

Table 1. Sample Nomenclature

S/n	Nomenclature of samples	Compositions of samples		
		% of petrol per liter	% of fuel injector cleaner per sample	Amount of camphor (g)
1	CI0	100	_	_
2	C2	100	_	2
3	C4	100	_	4
4	C6	100	_	6
5	C8	100	_	8
6	C10	100	_	10
7	I5	95%	5%	_
8	I10	90%	10%	_
9	I15	85%	15%	_
10	I20	80%	20%	_
11	I25	75%	25%	_

EXPERIMENTAL PROCEDURE

The engine performance and emission test were conducted on a four-stroke, single-cylinder, spark-ignition engine shown in figure 1. The engine was well secured to a test bench where its output shaft was coupled to the dynamometer rotor, which is brake by mechanical frictions.

A. Engine Test setup

B. Gas analyzer interface

Figure 1. Experimental setup for the performance and emission test

RESULT AND DISCUSSION

Physicochemical properties of the samples

Tests of the physicochemical properties were conducted, where properties like flash point, viscosity, density, Acid value, cetane number, iodine value of the samples were tested. The result is presented below and discussed.

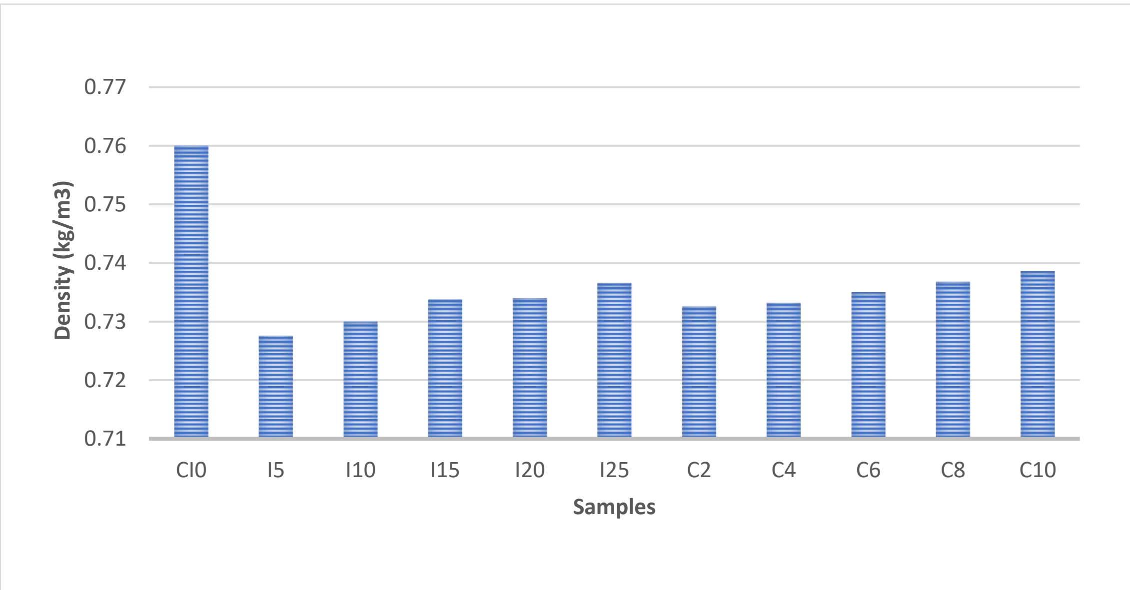

Figure 2. The density of the samples

From figure 2 above, it can be seen that, from all the samples, pure petrol (C10) appeared to have the highest density. Pollution emissions generally increase with the increase in fuel density.

Viscosity

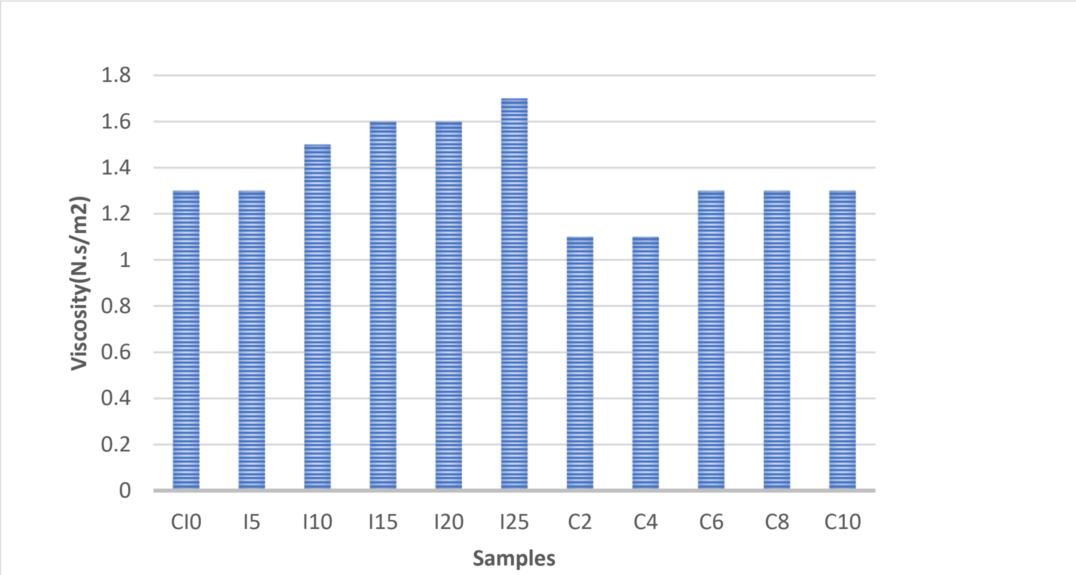

Figure 3. The viscosity of the samples

From figure 3 it was observed that the samples with the least viscosity are samples C2 and C4 as compared with the pure petrol (CI0) with a value of 1.3N.s/m^2 and I25 which has a value of 1.7N.s/m^2.

Emission test result

Carbon monoxide (CO)

Carbon monoxide (CO)is normally produced in an internal combustion engine due to insufficient oxygen to produce carbon dioxide (CO_2). the effect of camphor–Injector cleaner-petrol blends on Carbon monoxide (CO) emissions is shown in Figure 4.

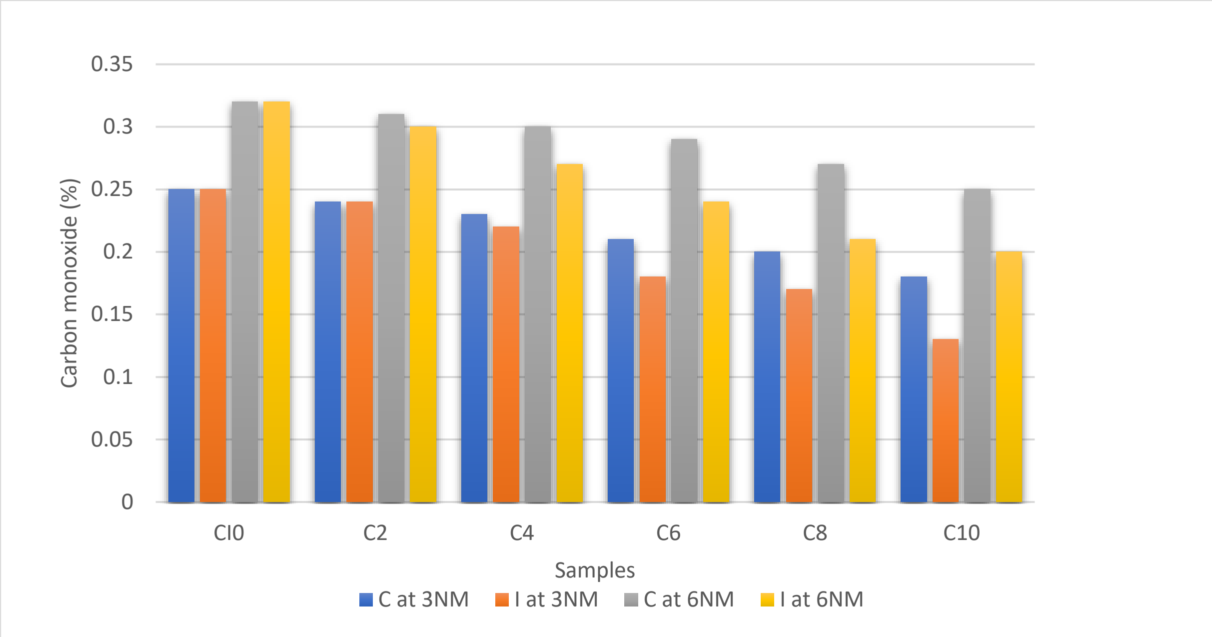

Figure 4. Carbon monoxide (CO) Emission

From the above Figure 4, it was shown that the addition of camphor to the sole petrol in this ratio decreases the emission of carbon monoxide in both 3Nm and 6Nm torques same applied to the petrol-injector blend. Finally, the best sample with the least emission of CO was found to be I25 with a CO emission of 0.2% and 0.13% at 3 Nm and 6 Nm respectively.

Carbon dioxide (CO_2)

The formation of carbon dioxide in the emitted gases indicates the complete combustion of the fuel in the combustion chamber. The effect of the camphor-injector cleaner-petrol blends on the CO_2 is shown in Figure 5.

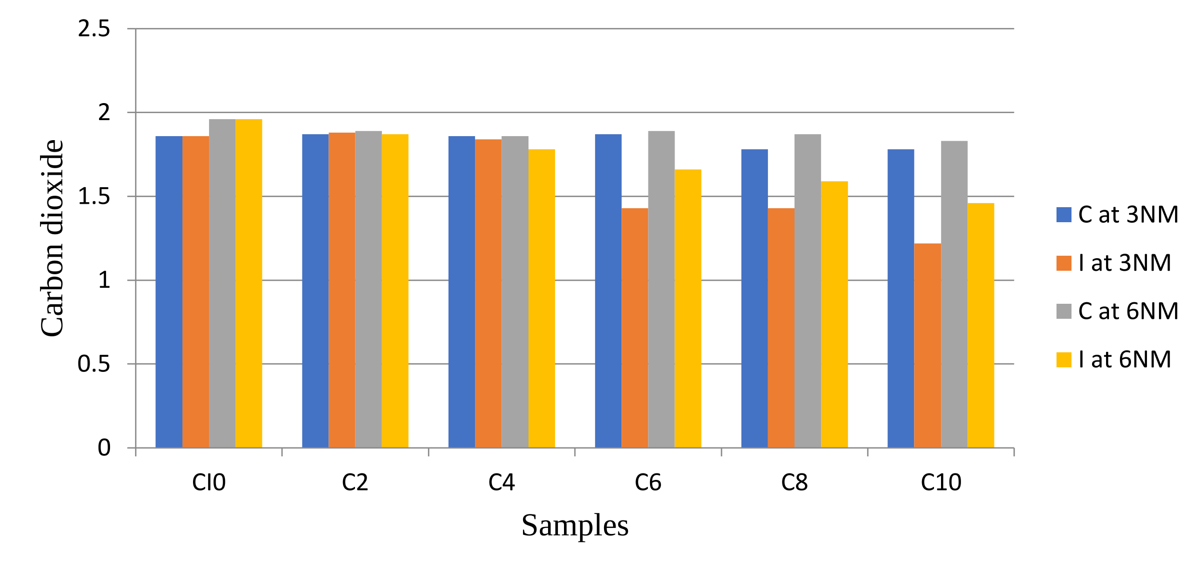

Figure 5. Carbon dioxide (CO_2) emission of the samples at 3 and 6Nm

The above figure 5 shows that the higher the percentage of injector cleaner the lower the amount of CO_2 emitted. It is also seen that the higher the amount of camphor in the sample the lower the emission of CO_2. From the result, it was found that the sample with the least emission of CO_2 for the two constant torque was sample I25 which have a value of 1.22 and 1.46% of CO_2 for 3 Nm and 6 Nm respectively

Hydrocarbons (HC)

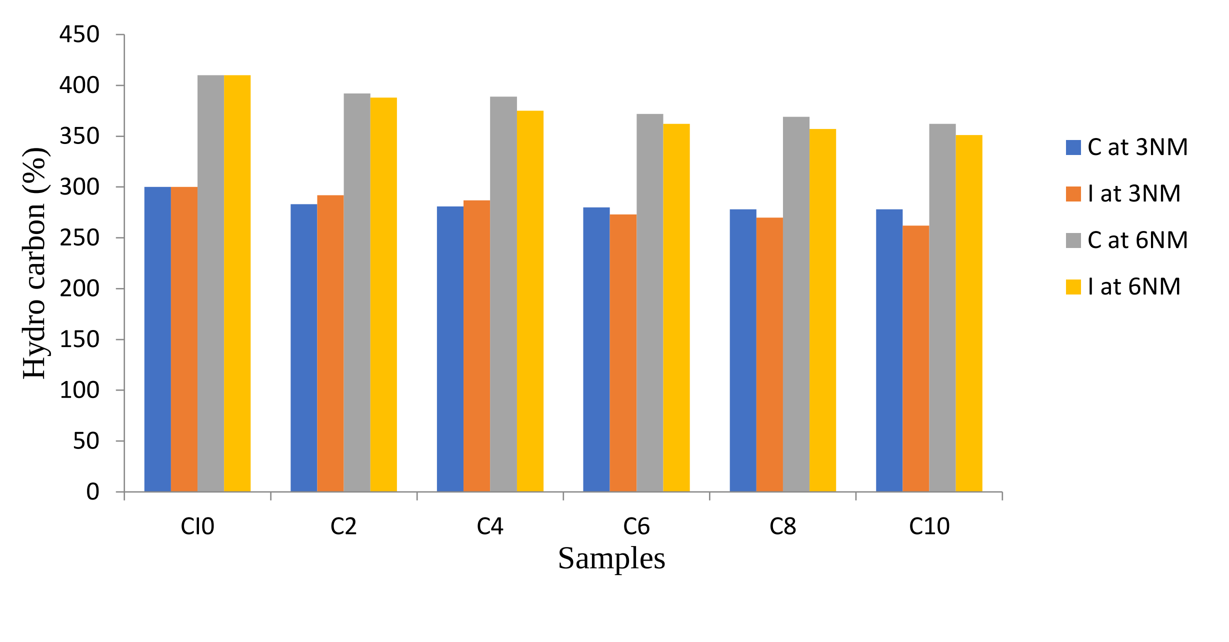

Figure 6. Hydrocarbon emission

From figure 6, it is shown that as the percentage of injector cleaner increases in the blend sample, the lower the amount of HC emitted. So also, with the camphor blends, where an increase in the amount of camphor in the sample shows to have lower the emission of HC. From the result, it was found that the sample with the least $HC_{emission}$ at all the two torque (3Nm and 6Nm) was sample I25 which has a value of 262 and 351 ppm of HC for 3 Nm and 6 Nm respectively.

Nitrogen oxide (NO_x)

This is a generic term for the nitrogen oxides that are most relevant for air pollution, namely nitric oxides (NO) and nitrogen dioxide (NO_2). NO_X is produced in the spark-ignition engine due to the combustion of air which contains some percentage of nitrogen and oxygen. The effect of the camphor-injector cleaner-petrol blends on the emission of nitrogen oxide is shown in Figure 7.

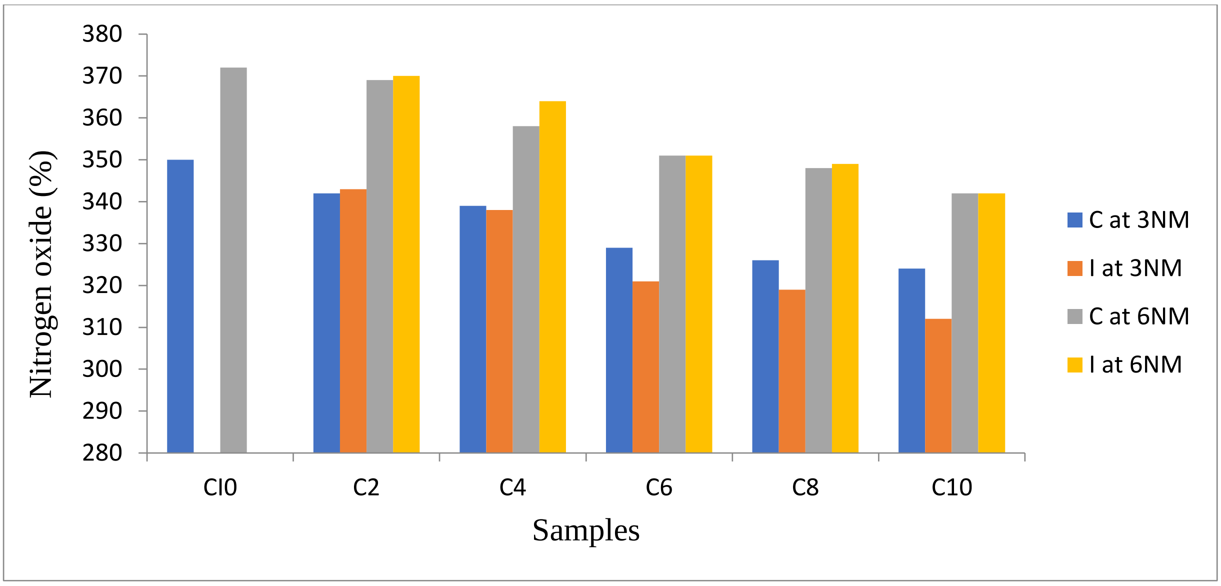

Figure 7. Nitrogen oxide (NO_x) emission of the samples at 3 and 6 Nm

Figure 7 shows that as the percentage of injector cleaner and camphor in the blend increases NO_X emission decreases significantly, it was also observed that the amount of NO_x emitted was insignificantly dependent on the torque run by the engine. Hence, from the result obtained, the sample with the least emission of NO_x was sample I25 with a value of 312 and 342 ppm at 3 Nm and 6 Nm respectively.

CONCLUSION

Considering the experimental results, and detailed analysis of the result, it was noted that sample I25 shows the best performance among all the samples treated in this experiment where it has the least emission of CO and CO_2 with a 0.2% and 0.13% at 3Nm and 6Nm for CO emission and 1.22 and 1.47% for CO_2 at 3Nm and 6 Nm respectively, concerning NOx emissions also sample I25, shows the best result was it reordered highest NOx emission reductions with a value of 312 and 342ppm at 3 and 6 Nm engine torque. It's also recorded the minimum specific fuel consumption among all the samples tested. This shows that with the regard to CO, CO_2, NOx emissions, and specific fuel consumptions, the sample with Injector cleaner, proved to be more effective than the sample with camphor.

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