EVALUATION OF HC PARAMETER IN COMMERCIAL DIESEL ENGINE FUELED WITH WASTE COOKING OIL DIESEL BLEND AT 10% RATIO

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Abstract

Aim : The aim of this research is to find suitable fuel for low HC emission by using biodiesel fuel with a blend at 10% by volume of waste cooking oil.
Material and Methods: Neat diesel blended with waste cooking oil (WCO) in the ratio of 10% by volume and fueled in a multi cylinder diesel engine which has a Bore diameter - 73mm and Stroke Length -110mm on the test bed. It was mounted with an eddy current dynamometer on the same base frame and experimented with conventional settings. For each fuel, 20 experiments were considered based on the G-power calculator with 80% power having alpha value 0.05 and 95% confidence level (CI).
Results: HC emissions for D90WCO10 blends was 73 ppm and for D100 it is 67 ppm with respect to 100% engine load. The significance values obtained for this group is 0.001 which is leuss than 0.05 ($p<0.05$) which shows that there is a significant difference among the fuels.
Conclusion: Within the limits of the study, there was nearly 17% of reduction in HCppm for D90WCO10 blend when compared with D100 neat diesel.

Keywords: Waste cooking oil (WCO), Diesel, Multi Cylinder Diesel Engine, Biodiesel, HC Parameters ,AVL gas analyser

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1. Introduction

In recent years, the demands for energy have grown very quickly due to the rapid development of certain growing economies, especially in Asia and the Middle East. Biofuels such as alcohols and biodiesel have been proposed as alternatives for diesel engines(Basheer and Anitha 2019) . Especially, the environmental issues concerned with the exhaust gas emission by the usage of fossil fuels also encourage the usage of biodiesel, which has proved to be eco friendly far more than fossil fuels. In particular, biodiesel has received wide attention as a replacement for diesel fuel because it is biodegradable, nontoxic and can significantly reduce toxic emissions and overall life cycle emission of HC(Kozarac, Mahalec, and Lulic 2008).Biodiesel is known as a carbon neutral fuel because the carbon present in the exhaust was originally fixed from the atmosphere . This supply deficit will have serious implications for many non-oil producing countries which are dependent on oil imports. Furthermore, the extensive use of fossil fuels has increased the production of greenhouse gas, especially carbon dioxide (HC), thus exacerbating the greenhouse effect(Llosa 2005). The potential to both reduce fossil fuel reliance and the release of (HC) to the atmosphere.

Based on the similar research 550 journals are published in science direct and 120 journal articles are available in(Pérez-Rodríguez, n.d.) google scholar from the last few years . Among all this journal's best cited papers are performance and emission study under a multi cylinder diesel engine fueled with waste cooking oil (WCO) (Sonthalia and Kumar 2021). Demand increases for fuels like (petrol, diesel) in recent years the demand for alternative renewable energy sources like biodiesel(Kalonji 2018) to reduce the HC emission in the Multi cylinder diesel engine. Due to the higher HC emission and maintenance expenses in diesel engines, mostly many peoples preferred to gasoline engines(*Experimental Investigation of Fuel-Reactivity Controlled Compression Ignition (RCCI) Combustion Mode in a Multi-Cylinder, Light-Duty Diesel Engine* 2011) for the sake of wellbeing . The best-cited paper among all those research papers is carried out .

Our institution is passionate about high quality evidence based research and has excelled in various domains (Rinesh et al. 2022; Sundararaman et al. 2022; Mohanavel et al. 2022; Ram et al. 2022; Dinesh Kumar et al. 2022; Vijayalakshmi et al. 2022; Sudhan et al. 2022; Kumar et al. 2022; Sathish et al. 2022; Mahesh et al. 2022; Yaashikaa et al. 2022). In the previous researches the waste cooking oil (WCO) blends was not utilized in any commercial diesel engines without any modifications. Since diesel fuel is used in the major commercial vehicles there is a need for alternative fuel to power the diesel engine to reduce the fuel cost and emission. We can experiment to see how WCO can be mixed with diesel in the diesel engine to check HC parameters . The experiment is made to obtain HCemission , the fuel is blended with waste cooking oil with 10% blend ratio in the CRDI diesel engine tested with D90WCO10.

2. Materials and Methods

The experimental investigation on the emission analysis of WCO diesel blend in commercial diesel engines was done in thermal engineering laboratory, Saveetha School of Engineering (SSE), Saveetha Institute of Medical and Technical Sciences (SIMATS) chennai. As no human samples were used, ethical approval was not required. Two groups were considered: experimental group 10% of WCO diesel blend (D90WCO10) and control group consisting of neat diesel (D100) for each group 20 samples were considered based on G-power calculator. From the previous studies the mean ME and standard deviation values for the experiment group is 95% and 0.005 whereas for the control group the mean and standard deviation values are 94% and 0.9.

Pure 100% diesel was brought from the nearby Shell petrol pump near SIMATS, Thandalam, Chennai. Because compared to other fuel station, shell petrol station provide diesel fuel with proper purity without any impurities. The calorific value is the capacity of fuel property which increases the capacity of burning rate. The density and viscosity of fuel is the mandatory property which intends to increase the atomization rate.

Waste cooking oil 10% was utilised in this study for blending along diesel, It was obtained from a nearby KFC outlet to maintain the uniformity of oil. It takes 48hrs to purify the waste cooking oil, one litre raw WCO was taken and temperature was supplied continuously from 600 ^{o}C to 650 ^{o}C with adding of methanol and KOH (200ml+17gms), irrefutably the running period of warming is around 20 minutes right after warming the contraption is used to disconnect the misfortune from the oil and filtration will be done the on 5 times with the water. As of now again warming the isolated bio-diesel in the temperature of 1000C. Keep the warmed biodiesel in a side for 48hrs to remove the waste cooking oil(WCO). The test blends were kept in isolation for five weeks and were found to be stable with no phase separation.

The experiment was carried out with a commercial diesel engine. It was hindustan motors Ambassador engine which has four cylinder in it. It is mounted with a direct injection system at a pressure of 250 bar. It was mounted with a single base frame along with a hydraulic dynamometer for load variations.

A separate water supply unit with a 1.5 hp motor was used cooling water circulation. The HC emissions were analysed using AVL five gas analyser and it was repeated 5 times to confirm the qualities of readings. The Fig 2 Shows the commercial diesel engine which was used for testing HC parameters with WCO diesel blend. This experiment was to find out the suitable fuel for reduced HC emissions in commercial diesel engine. The WCO was blended with diesel with 10% by volume D90WCO10 (90% diesel and 10% of waste cooking oil) and experimented. At first the engine was allowed to run with diesel fuel for 10 minutes to reach steady state condition. And then the WCO blend was fueled and the test was carried out for all five loads. Next neat diesel(Sahu 2017) was fueled and the test repeated for all five loads, all readings of HC was tabulated for diesel and WCO diesel blend.
The WCO was blended with diesel with 10% by volume D90WCO10 (90% diesel and 10% of waste cooking oil) and experimented. At the first engine was allowed to run with diesel fuel for 10 minutes to reach steady state condition. And then the WCO blend was fueled and the test was carried out for all five loads. Next neat diesel was fueled and the test repeated for all five loads, all readings of HC were tabulated for diesel and WCO diesel blend.

Statistical Analysis
waste cooking oil fuel consumption and Hc parameters was measured using a Data Acquisition System with the help of a Combustion pressure sensor which was mounted on the head of the combustion chamber. As the three values are independent of each other, independent samples ANOVA was performed for independent variables, to validate the results of the measured value,
statistical analysis was done using IBM-SPSS software.

3. Result

HC emissions for D90WCO10 blends was 73 ppm and for D100 it is 67 ppm with respect to 100% engine load, the better result shown in group 1 rather than group 2 in Table 3. The experiment was done on multi cylinder diesel engine and thereafter it was compared with diesel fuel waste cooking oil which shows the result condition when compared with diesel and biodiesel WCO D90WCO10 is lower when compared to diesel the HC parameter for D90WCO10 blend -19% is less than diesel when compared diesel

4. Discussion

Based on the experiment results HC concentrations of the WCO blends at the engine load variation. The NOx emissions increase was related to the higher engine load due to the fuel consumption increase. NOx emissions are affected by the oxygen concentration, fuel nitrogen content, cylinder combustion temperature and combustion time. Pyrolysis oil (Mahfud, Ghijsen, and Heeres 2007)has poor ignition properties due to the lower cetane number and resulted in lower HC emission of crude diesel(Del Carmen Cuevas-Díaz et al. 2022) . The blend ratio increase was found to better suppress the low NOx formation at higher engine load due to the lower cetane number of the pyrolysis oil which led to the longer ignition delay. This allows more time for the fuel preparation mixing and combustion . The oil oxygen content and lower cylinder temperature led to the lower adiabatic flame temperature and thermal . HCemissions values for diesel and oil blends of 25, 50, 70 and 100% at full load and, respectively, blend 10% loads like 25,50,75 and 100 at full load were 33,39,58,73. In this study we considerd only how to reduce NOx emission and smoke opacity in the engine. Neither property is not considered to be combustion of the waste cooking oil (WCO); the HC parameter (*Experimental Investigation of Fuel-Reactivity Controlled Compression Ignition (RCCI) Combustion Mode in a Multi-Cylinder, Light-Duty Diesel Engine* 2011)is lower in waste cooking oil (WCO) compared to diesel. The biodiesel from waste cooking oil was tested to investigate the impact of WCO percentage in blends with diesel oil.
The engine performance with biodiesel blends was found WCO blend is very low emission while experimented with multi cylinder diesel engine(Kozarac, Mahalec, and Lulic 2008). This study is not considering the effect of MGT. Ether property is not considered to be the combustion of the blended oil. It can be changed in the future for optimization by the multiple injections in the CRDi diesel engine. The parameter and higher level of C-V value will be found.

5. Conclusion

Within the limits of the study the D90WCO10 blend showed that there was nearly 18% reduction in HC ppm for D90WCO10 blend when compared with D100 neat diesel. Increased load parameters leads to increase in HC emissions, but D90WCO10 blend shows a favourable results when compared with D100 neat diesel. Through this research we obtained better results for the HC with the waste cooking oil blend compared to the plain diesel. From the research it was concluded that waste cooking oil blend can be used as a biofuel for decreasing the NOx in commercial multi cylinder diesel engine

Declarations

Conflict of Interests
There is no conflict of interest in this manuscript

Author Contributions
Author SSk was involved in data collection,data analysis and manuscript writing. Author MVD was involved in data validation and review of manuscripts.

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Tables and Figures

Table 1. properties of waste cooking oil were listed below for 100ml of waste cooking oil 100% and 10% blended with diesel fuel.

SNO	Parameters	Neat Wco	10% blends of Wco
1	specific gravity	0.8634 gm/cc	0.4865 gm/cc
2	velocity	3.60cst	6.20cst
3	calorific value	10954 kcals/kg	34658 kcals/kg
4	Acidity	19.0mg of koh/gm	11.4 mg of koh/gm
5	Ash	Nil	Nil
6	Fire point	75℃	55℃
7	Pour point	<4℃	<4℃
8	cloud point	<4℃	<4℃
9	carbon residue	Nil	Nil

10	flash point	59℃	42℃

Table 2. Hindustan motors multi cylinder ambassador diesel engine specifications was listed below.

1	Make	stride
2	BHP	10(de-rated)
3	Number of cylinders	four
4	Compression ratio (CR)	23: 1
5	Bore	73mm
6	Stroke	88.9mm
7	orifice meter	20mm
8	type of ignition	compression ignition
9	type of cooling	water cooled
10	type of starting	self start
11	method of loading	hydraulic dynamometer loading
12	speed	1500rpm

Table 3. HC readings for D90WCO10 blend obtained from AVL five gas analyser for 20 trials was listed below

Trails	HC Parameter
1	33
2	34.2
3	35.8
4	36.5
5	39
6	41
7	45
8	50
9	54
10	58
11	60
12	63
13	66

14	70
15	73
16	77
17	80
18	85
19	88
20	91

Table 4. HC readings for neat diesel 100% obtained from AVL five gas analyser for 20 trails was listed below

Trails	Neat diesel Results
1	20.9
2	21.4
3	22.7
4	23
5	27
6	32.5
7	36
8	41.4
9	44
10	46
11	52
12	53.5
13	60
14	67
15	70
16	74
17	77
18	80
19	84
20	88

Table 5. Independent samples T-test -SVM seems to be significantly better than LR

Group	N	Mean	Std. Deviation	Std. Error Mean
HC	20	57.4250	19.34305	4.32524
Diesel	20	48.7750	23.97729	5.36148

Table 6. Levene's test for equality of variances

Hypothesis	F	Sig	t	df
Equal variances assumed	3.522	0.023	1.256	38
Equal variances not assumed			1.256	36.372

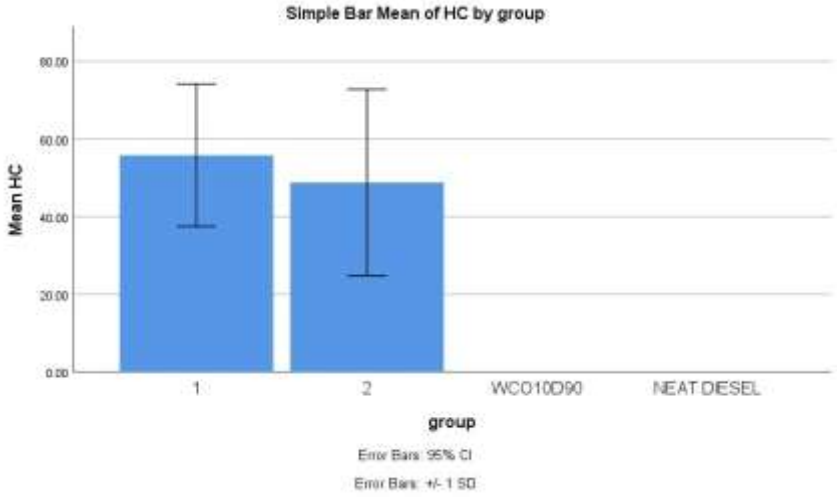

Fig 1. x-axis depicts mean HC parameters values of WCO/Diesel blends and Y-axis D90WCO10 & D100 blends values increased by 100% by volume (+/-1SD). in this graph the group 1 shows D90WCO10 graph value and the group 2 shows Neat Diesel D100 graph value in the above graph showed

Fig. 2. Multi cylinder engine test bed of Hindustan motors Ambassador vehicle