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Prediction of Combustion, Performance and Emission of Anisole and Diesel in agriculture Diesel engine which is compared with using statistical Method.

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ABSTRACT

Aim: This study aims to find the suitable fuel for the best In-Cylinder Pressure,Heat Release Rate, BTE, BSFC and lower Co, NOx and Smoke opacity of Anisole and Diesel blend compared with Diesel fuel. **Materials and Methods:** Anisole was blended at (10%, 20% & 30%) with Diesel to choose the best blend, the best blend was compared with Diesel. Single Cylinder Kirloskar DI engine which has Bore - 87.5mm diameter and stroke length-110mm onboard stationary engine coupled with Eddy Current Dynamometer, It was experimented with conventional settings considering 20 sample sizes, and the power is 0.8, which G-Power determines with G power calculator v-3.1.9.7. **Results:** Based on the experimental trials In-Cylinder pressure - 86.95bar, Heat release rate -72.27 J/deg, BTE - 86.25bar, Brake specific fuel consumption - 72.27 J/deg, NOx- 86.95 bar and Smoke opacity -72.27. The significance variance exists among the considered groups p=0.039 ($p<0.05$). **Conclusion:** Within the limits of the study, In-Cylinder pressure is 7% higher when compared with Diesel. The heat release rate for D70A30- 2% higher when compared with Diesel .The BTE of D70A30- 7% higher when compared with DieselThe NOx for D70A30- 2.4% higher when compared with Diesel. **Keywords:** Novel blend, Green Energy, Anisole, Diesel, Combustion, In-Cylinder Pressure, Heat release rate, Nitrous oxide, Carbon Monoxide, Smoke opacity and Environmental engineering.

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INTRODUCTION

To compensate for fossil fuel demands and to reduce the risk of environmental engineering hazards utilization we take green energy Anisole higher alcohol as the best solution. Biofuel derived from lignin processing is used to produce Diesel-like fuel also known as Anisole and it can be used as fuel in Diesel engines (D. Damodharan et al. 2018). In this study Anisole blends exhibit higher mass gas temperature than the other fuel due to their higher oxygen content. Due to high volumetric efficiency when compared to petrol engines (Rajesh Kumar 2018). Diesel plays an important role in the global automobile sector. High fuel consumption and increase in fossil fuel demands because of Rapid urbanization and Environmental engineering development(L. Damodharan et al. 2001).

In view of comparative exploration, 550 diaries are distributed in Science Direct and 117 diaries are accessible in google researcher from the most recent 5 years. Among those diaries, the best-refered to papers are Performance and emanation investigation of a solitary chamber Diesel motor fuelled with n-octanol/WPO for certain changes. It is feasible to recuperate phenol by means of the vaporization cycle as an elective answer for redressing (Demirbas 2008) fossil fuel demands. The gamble of natural urbanization and industrialization has expanded. There is an interest for non-renewable energy sources consistently (Jahnig 1975). It must be noticed that fossil Diesel represented more when contrasted and fuel utilization. For example, India has consumed 6.9 million Diesel in 2012-2013 which is multiple times more than fuel. There is a gauge that the hold of unrefined petroleum is relying upon grade esteem at the pace of 2.1% per annum. Consequently it is basic that adjustment types of Diesel motor viable energizes must be recognized (Thillainayagam et al. 2017). Already our group has a rich involvement with chipping away at different exploration projects across various disciplines (Samuel et al. 2019; Johnson et al. 2020; Venu, Subramani, and Raju 2019; Keerthana and Thenmozhi 2016; Thejeswar and Thenmozhi 2015; Krishna and Babu 2016; Subashri and Thenmozhi 2016; Sriram, Thenmozhi, and Yuvaraj 2015; Jain, Kumar, and Manjula 2014; Menon and Thenmozhi 2016)

In the previously carried out works no Anisole blend was made with varying engine modifications (Viswanathan and Paulraj 2020)The major and the main part of the project is the novel blend ratio and injection timing variations which is to evaluate the combustion boost (Boot 2016). Different CI and CRDi motors Diesel motors offer unrivaled fuel protection and productivity and high force energy at low motor speed (Pepelko, Danner, and Clarke 1980). Furthermore, toughness because of this vital job as power trains in significant areas like assembling transport, power generators, and agribusiness Diesel motors have a significant job in the influence of the worldwide economy (Thillainayagam et al. 2017). The current review means to research the expansion in Anisole division with Diesel in a Diesel motor.

MATERIALS AND METHODS

All logical grades were bought from a nearby provider in Chennai, Diesel was bought from the Bharath petroleum bunk near to Saveetha University Chennai. Anisole was purchased from local chemical sellers in Parrys Chennai. A single-cylinder CRDi Diesel engine was used at the thermal engineering lab, Saveetha school of engineering, Saveetha Institute of Medical and Technical Sciences, Chennai. This engine was coupled with an eddy current dynamometer and built on the same base frame. The sample size was reduced to 80 and was split into two classes depending on the different novel blends. The power is 0.8, with a mean of 0.041 and a standard deviation of 2.1 which was calculated with G power calculator v.3.1.9.7 (Gopal et al. 2018).

Table. 1, shows the experimented fuels D70A30 blend (Diesel-70%by volume+ Anisole 30 %),Blends prepared with blending fuels designed the following: 1) D70A30 (Diesel-70% of volume+ Anisole 30% of volume). The test blend has been isolated for 5 weeks to find the condition of stability, no phase separation was found (Demirbas 2008).The below given figures give an elaborative explanation of the different blends that were used,The various chemicals that were used to blend the given values

Figure. 1, shows the single cylinder CI Diesel engine was used for testing the heat release rate and In-cylinder Pressure. Diesel and Anisole were blended at the rate of D90/A10, Diesel 90%, and Anisole 10%, and Diesel 80% and Anisole 20% and Diesel 70% and Anisole 30%. The test blend was kept isolated for 5 weeks to find the condition of stability, and no phase separation was found. The test of the binary blend experimented with a single-cylinder CI Diesel engine and thereafter it was compared with Diesel fuel, which showed a confirmatory result condition when compared with Diesel. The combustion In-cylinder pressure and Heat release rate from the CI engine was tabulated with the help of a data acquisition system which was connected with a Krystler Pressure sensor mounted on the head of the cylinder Table.2 shows the full setup. The combustion pressure and heat release rate from the CI engine was tabulated with the help of a Data acquisition system which was connected with a Krystler Pressure sensor mounted on the head of the cylinder (D. Damodharan et al. 2018).

STATISTICAL ANALYSIS

In-cylinder Pressure and Heat release rate were measured using a Data Acquisition System with the help of a

Combustion pressure sensor which was mounted on the head of the combustion chamber. In Fig. 2, To validate the results of the measured value, statistical analysis was done using IBM-SPSS software. As the three values are independent of each other, independent samples ANOVA was performed for independent variables heat release rate and In-cylinder pressure. Table. 3, shows Integral qualities for ANOVA variance and standard deviations examination factors. Utilizing SPSS, information could be imported from different sources like accounting pages, data sets and text documents or just new information could be entered. Fig. 3, shows the bar chart graph difference of mean value between blends.

RESULTS

Based on the trials, Fig. 4, shows the In-Cylinder pressure for neat Diesel- 79.5765bar, the best blend was D70A30- 86.953125 bar. Fig. 5, shows the heat release rate for neat Diesel- 59.75 J/deg, the best blend D70A30- 72.27 J/deg when compared to Diesel fuel.

Independent sample test shows statistical insignificance (p=0.039) for CI engine concentration between Anisole and Diesel for HRR. In the independent sample test, the significance of the HRR was determined.

Figure. 6 shows the ANOVA analysis which was carried out between groups and within groups. This analysis shows statistical insignificance for CI engine concentration between Anisole and Diesel for HRR using this analytical data the HRR value of the blends was obtained. Fig7 shows the ANOVA analysis carried out between groups and within groups. The In-cylinder pressure for the blends was obtained from the analysis.

The variation of In-cylinder pressure at different crank angle positions for the various test samples at peak load conditions are depicted in Fig. 8 and Fig. 9.

DISCUSSION

The In-Cylinder pressure for D70A30- 7% higher when compared with Diesel. The heat release rate for D70A30- 2% higher when compared with Diesel (Raj, Yoganandam, and Victor 2021). In-cylinder pressure measurements assist to interpret the relationship between heat energy and mechanical work (Projoth, Victor, and Nanthakumar 2021). Table. 3, shows the independent sample test which was performed between groups and within groups (Shanmugam et al. 2021).

Table. 4 shows the independent sample test analysis which was performed between groups and within groups (Sathish, Jose Arul, et al. 2021).

The combustion analysis of the Diesel 90% and Anisole 10% was calculated by a single cylinder. The heat release rate is increased by 0.2% when compared to Diesel, in the case of in cylinder pressure it has shown a good confirmatory value of 0.7% increase when compared to Diesel. Furthermore, it will be very useful for generators and Diesel pumps (Sesharao et al. 2021). The heat release rate is the proportion of a motor that changes over the synthetic energy of the fuel into heat energy through the interaction of ignition (Raju, Depoures, and Kumaran 2021). The varieties of warmth discharge rate versus wrench plot for all test mixes in correlation with standard Diesel at the evaluated power yield of the motor (Sathish, Palani, et al. 2021). The heat discharge rate (HRR) for benchmark Diesel D90A10, D80A20 and D70A30 mixes are 57.75 J/deg, 70.27 J/deg, 72.13 J/deg. Combustion from the In-cylinder pressure for premixed in primary fuel depends on pressure (Raju et al. 2021). The In-cylinder pressure fundamentally relies upon the fuel burnt within the premixed combustion phase, compared to the pressure traces for the test fuels with reference to the crank angle at the engine peak load condition (Paul, Victor, and Yoganandam 2021). Due to high LHV when compared with Diesel the combustion characteristics of Anisole produces good positive work inside the combustion chamber (Paul, Victor, and Yoganandam 2021).

Limitations of this study may not consider the effect of MGT. Ether property was not included in the combustion of plastic oil. It can be changed in the future for optimization by the multiple injections in the CRDi Diesel engine. The parameter and the high level of C-V value can be seen.

CONCLUSION

Within the limits of the study, Investigating the comparative assessment and improvement in 10% & 15% increase of HRR and PT. The increase in HRR resulted in better combustion characteristics of the CI engine and due to this the amount of fuel energy consumed is reduced. When compared with the In-cylinder pressure of Diesel there is a 7% increase in efficiency. D70A30 acts as the best blend which thereby reduces the Diesel contribution and reduction in fuel cost for the rural & agriculture sector.

DECLARATIONS:

Conflict of Interests

There is no conflict of interest in this manuscript.

Author Contributions

Author EK 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

Fig. 1. Engine setup is a single-cylinder Kirloskar bore, stroke length mounted on the same base frame with eddy current.

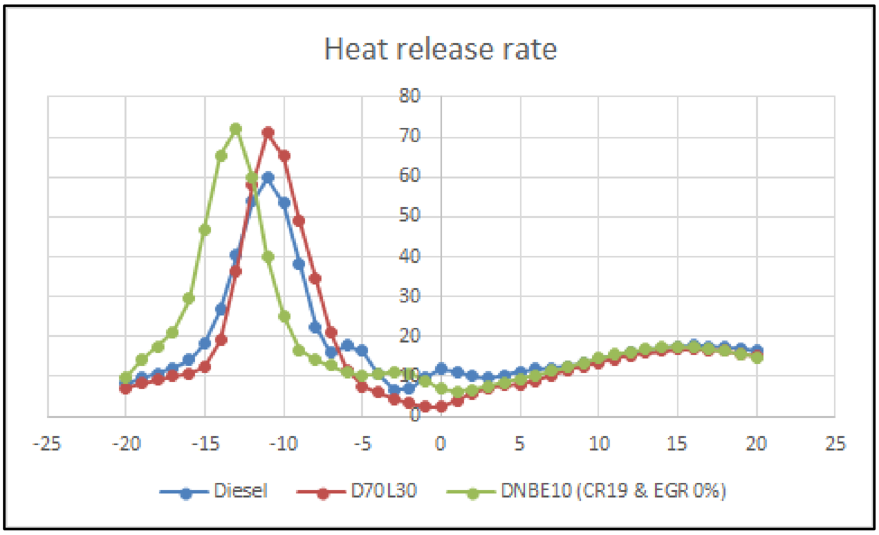

Fig. 2. Heat Release rate pressure measurement for Anisole /Diesel blend, depicts X-axis pressure values of Diesel blends and Y-axis standard crank angle.

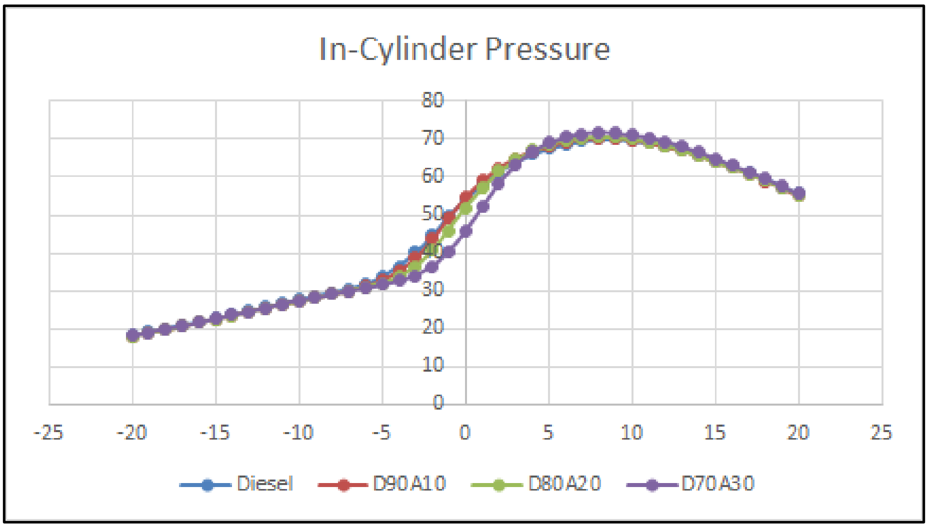

Fig. 3. In-cylinder pressure measurement for Anisole/Diesel blend, depicts X-axis pressure values of Diesel blends and Y-axis standard crank angle.

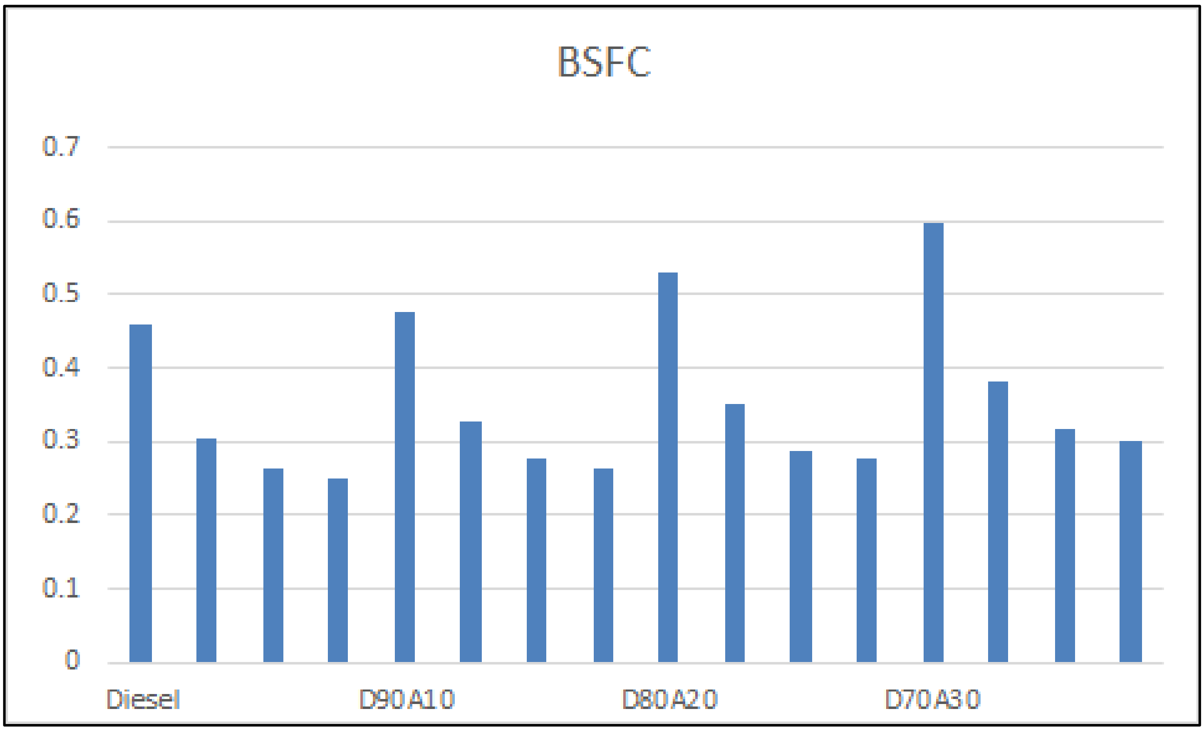

Fig. 4. Variation of BSFC rate at Y axis and different blends at X axis.

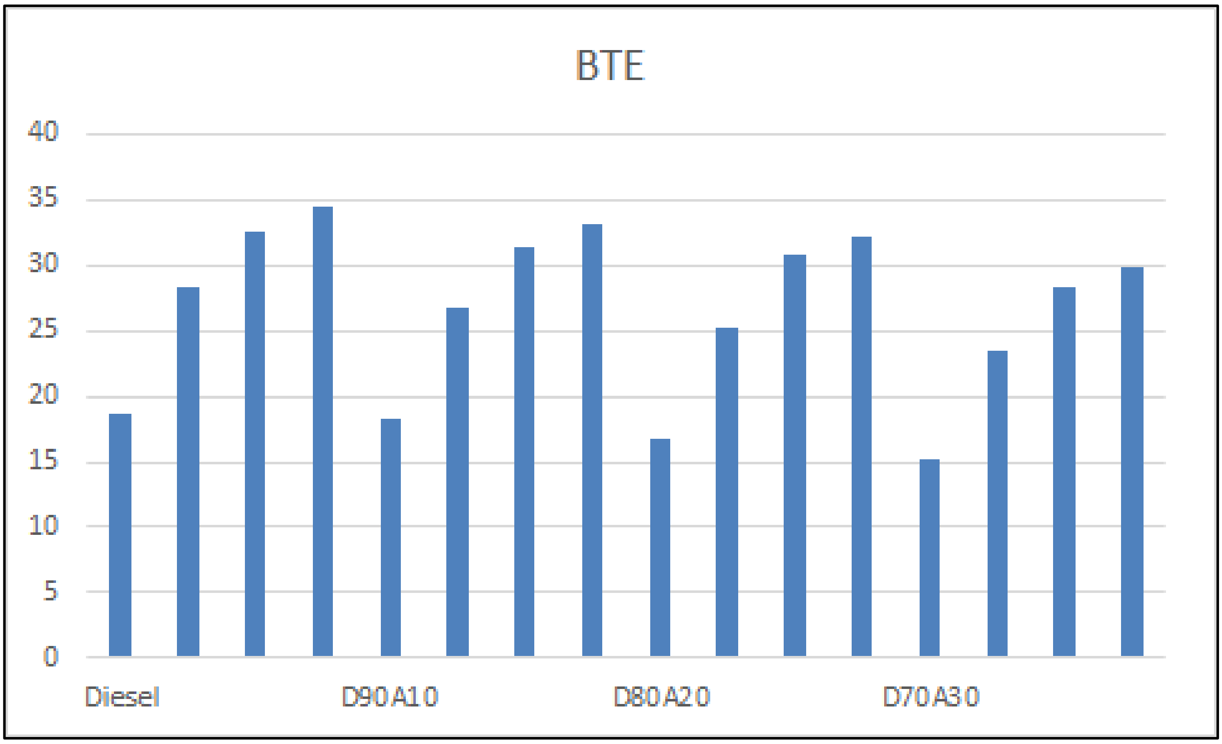

Fig. 5. Variation of BTE at Y axis and different blends at X axis.

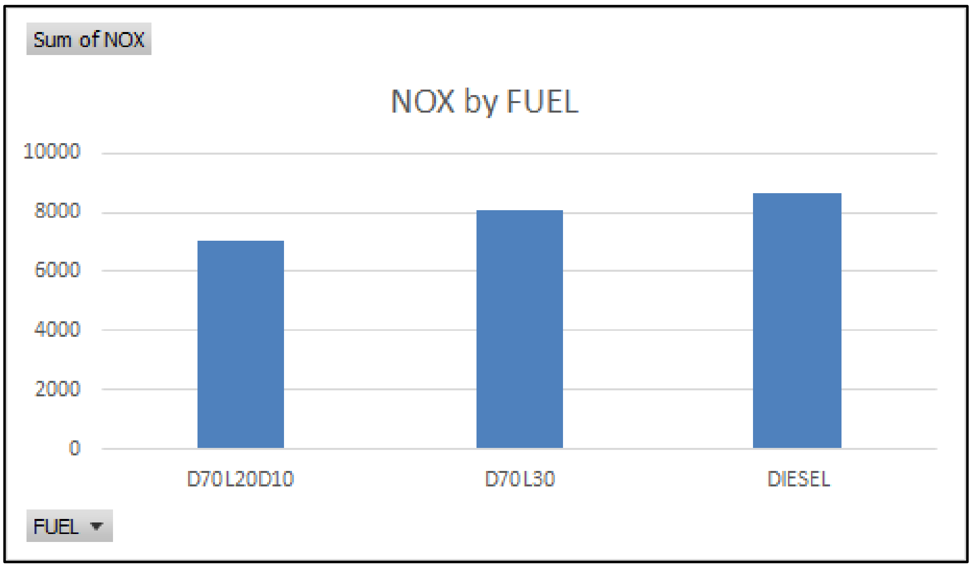

Fig. 6. NOx comparison of Diesel ,D70L30 and D70L20D10. The above mentioned graph depicts X-axis values of Diesel blends and Y-axis Fueling ratio.

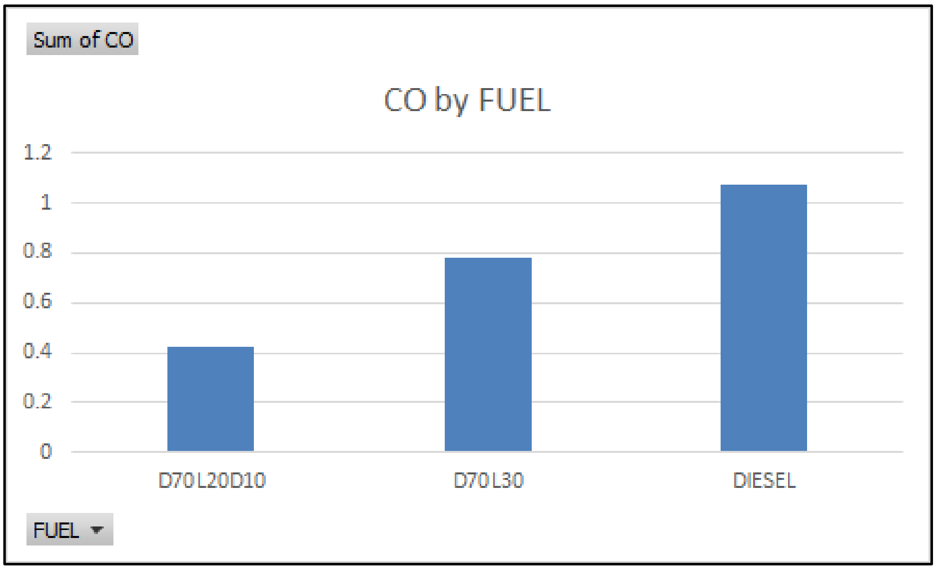

Fig. 7. The Co emission is given above for the comparison of Diesel,D70L30,D70L20D10,and the graph depicts values of Diesel blends in X-axis and fueling in Y-axis.

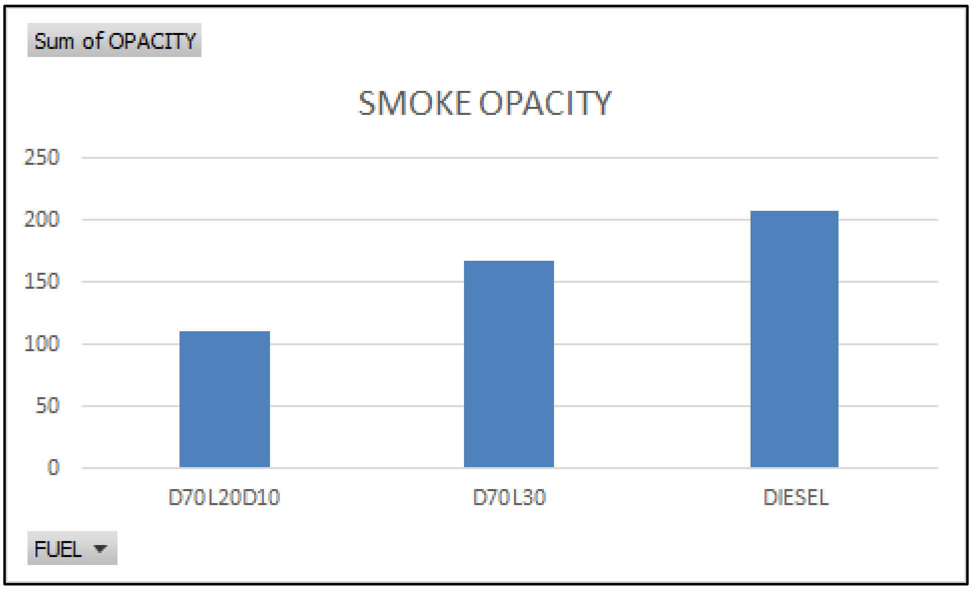

Fig. 8. The Smoke opacity comparison is given above for the comparison of Diesel,D70L30,D70L20D10,and the graph depicts values of Diesel blends in X-axis and fueling in Y-axis.

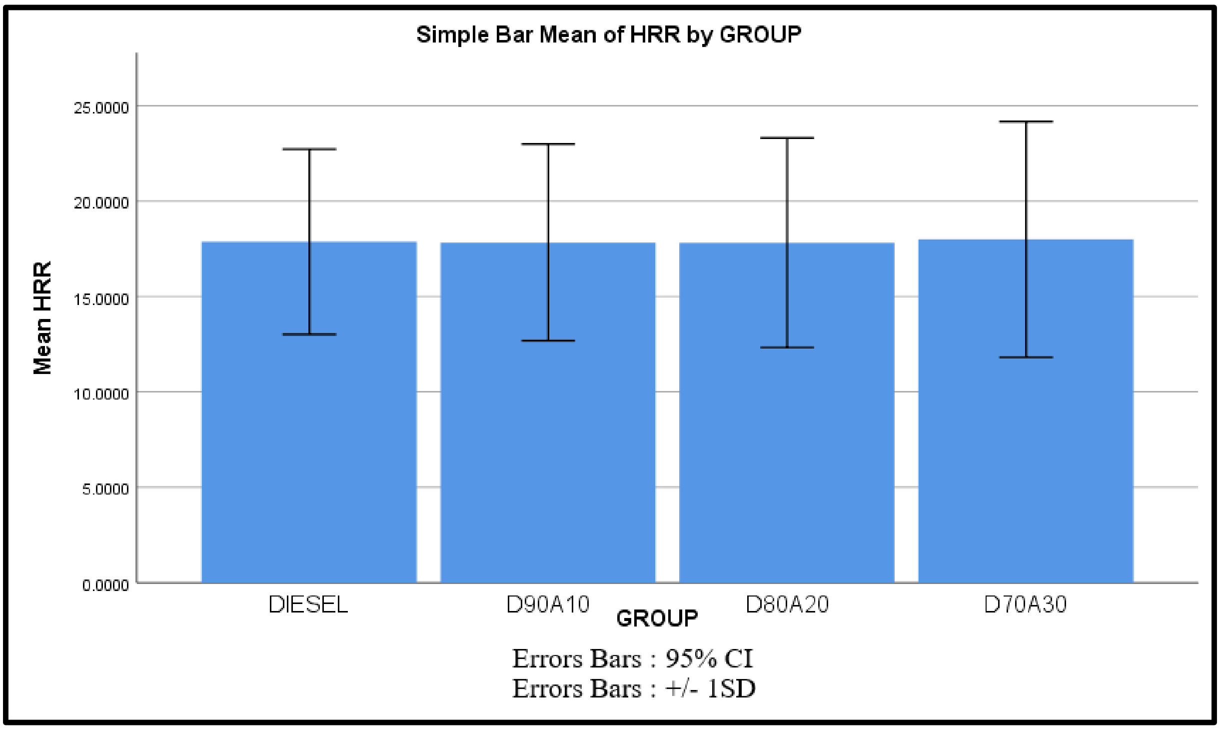

Fig. 9. Heat release rate measurement for Anisole /Diesel blend, below mentioned graph depicts X-axis values of Diesel blends and Y-axis standard crank angle, Diesel is increased by 100% by volume (±1 SD).

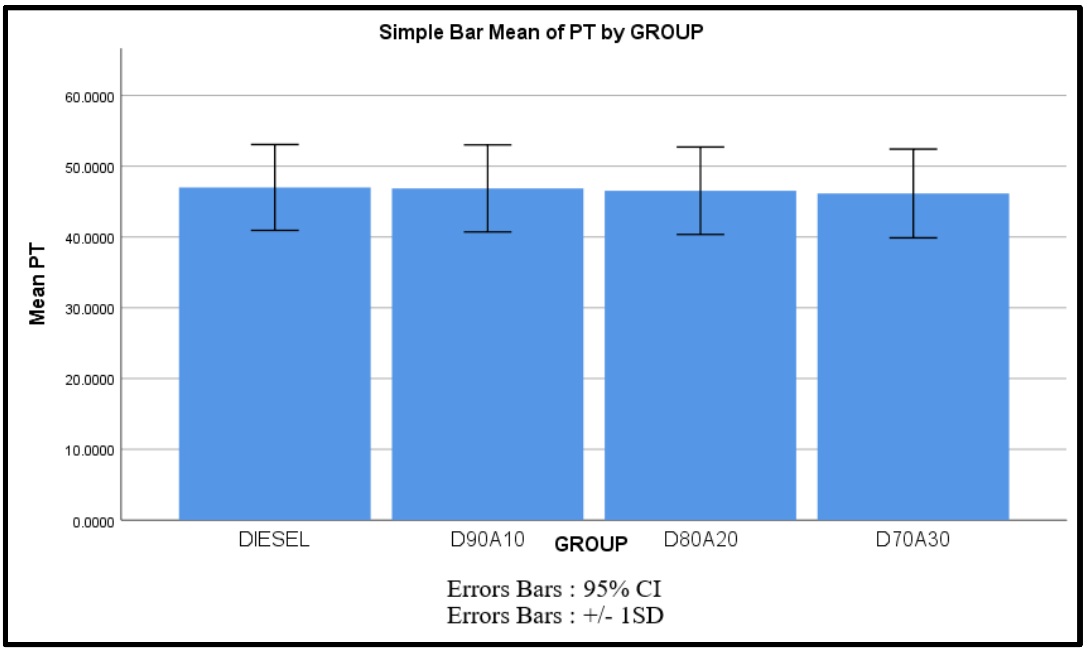

Fig. 10. In-Cylinder Pressure measurement for Anisole /Diesel blend, below mentioned graph depicts X-axis values of Diesel blends and Y-axis standard crank angle, Diesel is increased by 100% by volume (±1 SD).

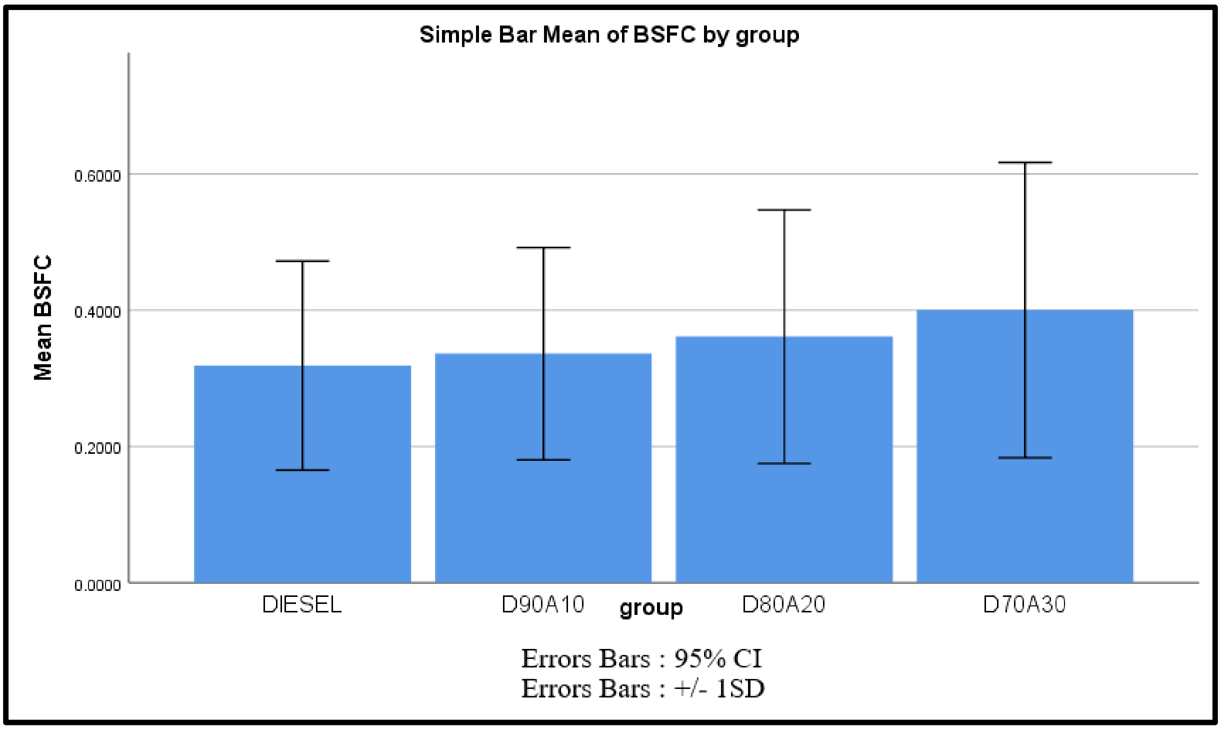

Fig. 11. Variation of BSFC at Y axis and different blends at X axis. Diesel is increased by 100% by volume (±1 SD).

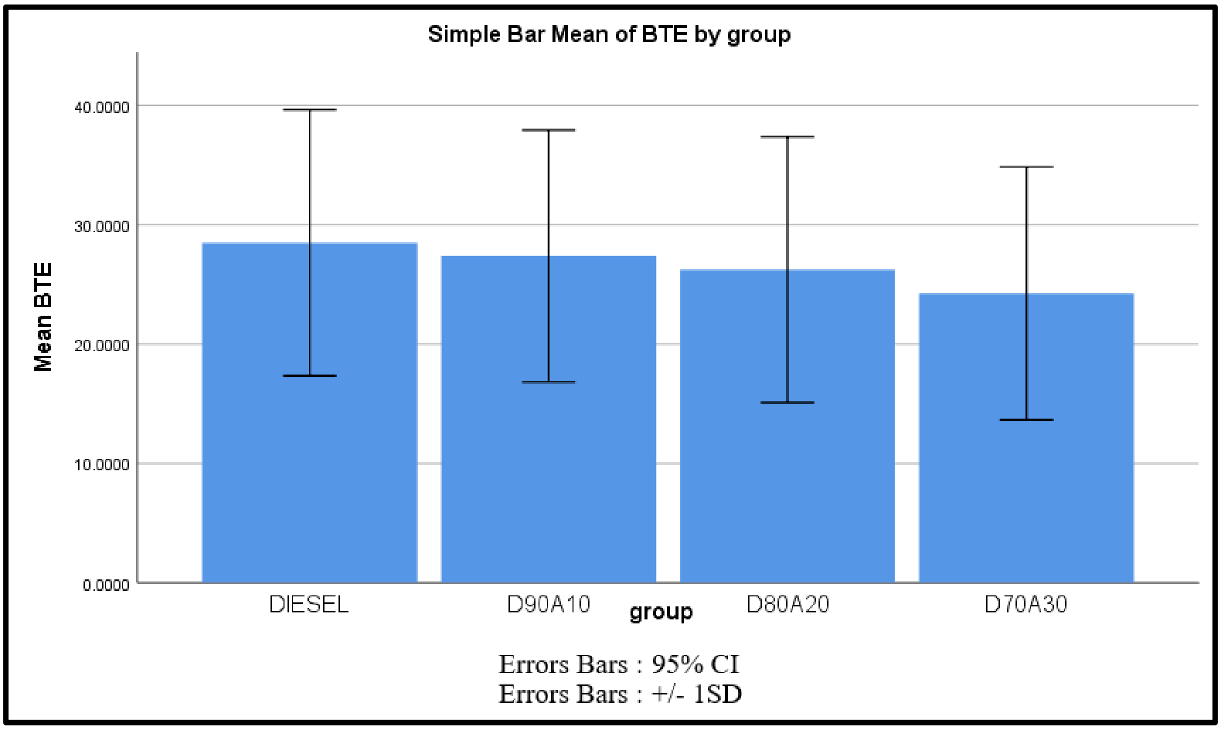

Fig. 12. Variation of BTE at Y axis and different blends at X axis, Diesel is increased by 100% by volume (±1 SD).

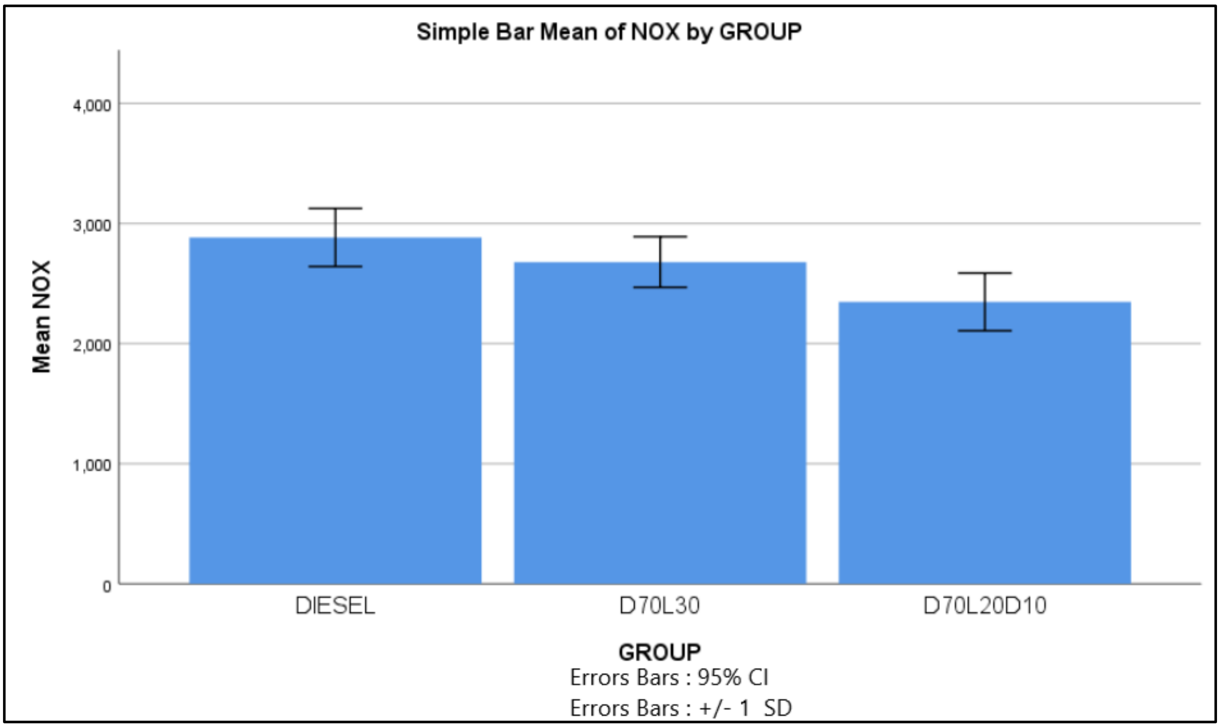

Fig. 13. NOx for DECANOL /Diesel blend, above mentioned graph depicts X-axis values of Diesel blends and Y-axis fuel percentage is increased by 100% by volume (±1 SD).

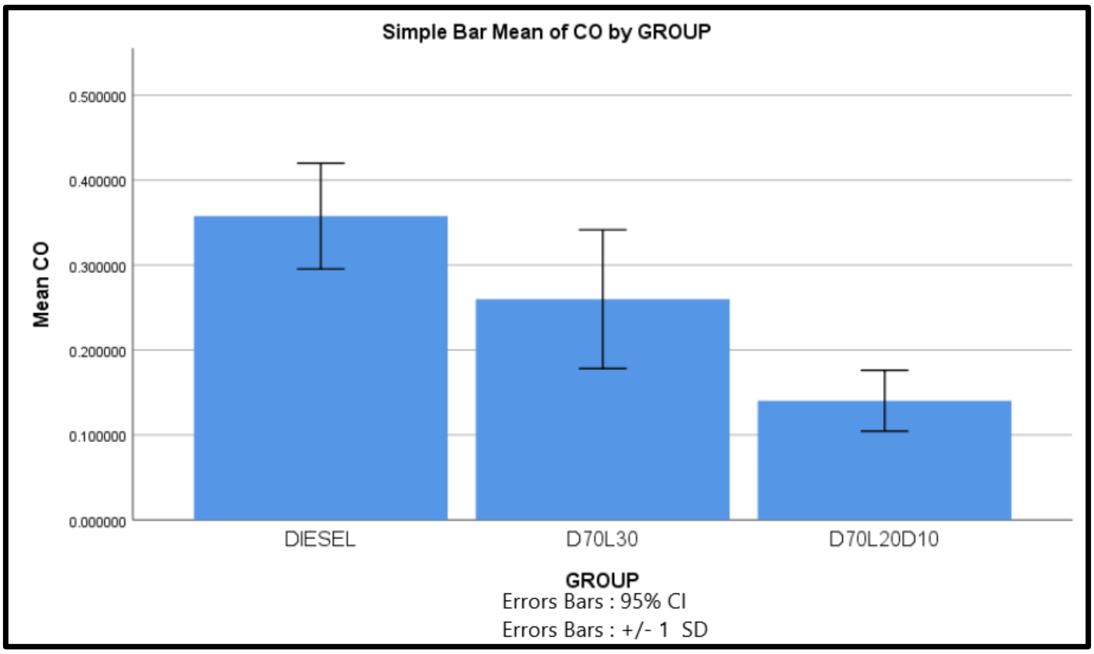

Fig. 14. Co for WLDPE/DECANOL/Diesel blend, above mentioned graph depicts X axis values of Diesel blends and Y axis fueling of Diesel is increased by 100% by volume (± 1SD).

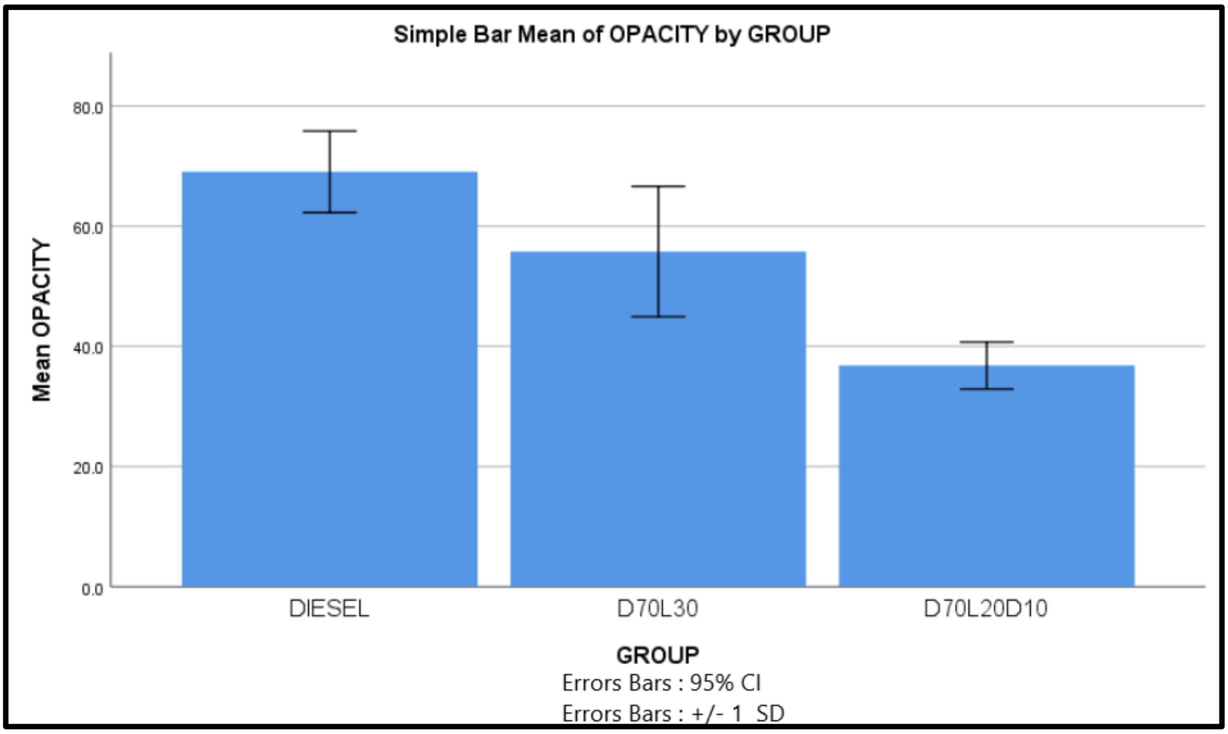

Fig. 15. Smoke Opacity measurement for WLDPE/DECANOL/Diesel blend, above mentioned graph depicts X axis values of Diesel blends and Y axis fueling of Diesel is increased by 100% by volume (± 1SD).

Table. 1. Tested fuel for physical properties, The physical properties are Density, Kinematic viscosity, LHV, Lantern heat of vaporization, Flashpoint.

Properties	Diesel	Anisole	D90A10	D80A20	D70A30
Kinematic viscosity (at 40°C)	2.93	2.75	0.69	3.482	3.86
Density (at 15°C (kg/m^3)	830	833	767	831.5	830.4
LHV	42.5	43.5	38.75	41.28	41.60
Latent heat of vaporization (kJ/kg)	250	-	346	-	-
Flashpoint (°C)	75	45	25	62	66

Table. 2. Engine specifications are the number of cylinders in stroke, bore, stroke length, swept volume, compression ratio, rated output, rated speed, cooling system, lubrication oil, injection timing, CA TDC & injection pressure.

Description	**Value**
Number of cylinders	one
Stroke	four
Bore	87.5 mm
Stroke length	110 mm
Swept volume	661 cc
Compression ratio	17.5
Rated output	3.5kw at 1500 rpm
Rated speed	1500 rpm
Cooling system	Water-cooled
Lubrication oil	SAE 40
Injection timing, CA TDC	23°
Injection pressure	600 bar

Table. 3. The Anova POSTHOC is carried out for CI engine concentration between Diesel and Anisole for HRR

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
DIESEL	D90A10	.0413457	3.8072510	0.039
	D80A20	.0527542	3.8072510	0.68
	D70A30	-.1216228	3.8072510	0.92
D90A10	DIESEL	-.0413457	3.8072510	1.000
	D80A20	.0114085	3.8072510	0.58
	D70A30	-.1629685	3.8072510	1.000
D80A20	DIESEL	-.0527542	3.8072510	0.004
	D90A10	-.0114085	3.8072510	1.000
	D70A30	-.1743770	3.8072510	1.000
D70A30	DIESEL	.1216228	3.8072510	0.68
	D90A10	.1629685	3.8072510	0.78
	D80A20	.1743770	3.8072510	0.0003

Table. 4. The ANOVA POSTHOC is carried for CI engine concentration between Diesel and Anisole for pressure.

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
DIESEL	D90A10	.1407165	4.3147094	0.620
	D80A20	.4718445	4.3147094	0.78
	D70A30	.8540549	4.3147094	0.114
D90A10	DIESEL	-.1407165	4.3147094	0.885
	D80A20	.3311280	4.3147094	1.000
	D70A30	.7133384	4.3147094	1.000
D80A20	DIESEL	-.4718445	4.3147094	0.003
	D90A10	-.3311280	4.3147094	1.000
	D70A30	.3822104	4.3147094	0.558
D70A30	DIESEL	-.8540549	4.3147094	1.000
	D90A10	-.7133384	4.3147094	0.91
	D80A20	-.3822104	4.3147094	0.004

Table. 5. The Anova POSTHOC is carried out for CI engine concentration between Diesel and Anisole for BTE p=1.000 where the (p>0.0005) which is insignificant.

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
DIESEL	D90A10	.0413457	3.8072510	0.338
	D80A20	.0527542	3.8072510	0.015
	D70A30	-.1216228	3.8072510	0.19
D90A10	DIESEL	-.0413457	3.8072510	0.006
	D80A20	.0114085	3.8072510	0.77
	D70A30	-.1629685	3.8072510	0.85
D80A20	DIESEL	-.0527542	3.8072510	0.008
	D90A10	-.0114085	3.8072510	0.00068
	D70A30	-.1743770	3.8072510	0.401
D70A30	DIESEL	.1216228	3.8072510	0.621
	D90A10	.1629685	3.8072510	0.218
	D80A20	.1743770	3.8072510	1.000

Table. 6. The ANOVA POSTHOC is carried for CI engine concentration between Diesel and Anisole for BSFC p=1.000 where the (p>0.0005) which is insignificant.

Multiple Comparisons				
(I) group	**(J) group**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
DIESEL	D90A10	-.0175318	.0798828	0.14
	D80A20	-.0425181	.0798828	1.000
	D70A30	-.0814146	.0798828	0.058
D90A10	DIESEL	.0175318	.0798828	1.000
	D80A20	-.0249863	.0798828	1.000
	D70A30	-.0638827	.0798828	0.253
D80A20	DIESEL	.0425181	.0798828	1.000
	D90A10	.0249863	.0798828	0.225
	D70A30	-.0388965	.0798828	0.006
D70A30	DIESEL	.0814146	.0798828	0.0052
	D90A10	.0638827	.0798828	0.152
	D80A20	.0388965	.0798828	0.00885

Table. 7. The Anova POSTHOC is carried out for CI engine concentration between Diesel and Anisole for NOx and an insignificant difference value is observed between the two groups ($p>0.005$)

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
DIESEL	D90A10	.0413457	3.8072510	0.06800
	D80A20	.0527542	3.8072510	0.2580
	D70A30	-.1216228	3.8072510	1.10
D90A10	DIESEL	-.0413457	3.8072510	0.0058
	D80A20	.0114085	3.8072510	0.0004
	D70A30	-.1629685	3.8072510	0.114
D80A20	DIESEL	-.0527542	3.8072510	0.254
	D90A10	-.0114085	3.8072510	0.005
	D70A30	-.1743770	3.8072510	0.112
D70A30	DIESEL	.1216228	3.8072510	0.524
	D90A10	.1629685	3.8072510	0.0058
	D80A20	.1743770	3.8072510	1.110

Table. 8. The ANOVA POSTHOC is carried for CI engine concentration between Diesel and Anisole for Smoke opacity.

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
DIESEL	D90A10	.1407165	4.3147094	.554
	D80A20	.4718445	4.3147094	0.114
	D70A30	.8540549	4.3147094	1.000
D90A10	DIESEL	-.1407165	4.3147094	1.000
	D80A20	.3311280	4.3147094	1.11
	D70A30	.7133384	4.3147094	0.15
D80A20	DIESEL	-.4718445	4.3147094	0.005
	D90A10	-.3311280	4.3147094	0.008
	D70A30	.3822104	4.3147094	0.254
D70A30	DIESEL	-.8540549	4.3147094	0.55
	D90A10	-.7133384	4.3147094	1.25
	D80A20	-.3822104	4.3147094	0.98

Table.9. The ANOVA POSTHOC is carried for CI engine concentration between Diesel and Anisole..

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error
DIESEL	D90A10	.0325000	.0291145
	D80A20	.0297500	.0291145
	D70A30	.0200000	.0291145
D90A10	DIESEL	-.0325000	.0291145
	D80A20	-.0027500	.0291145
	D70A30	-.0125000	.0291145
D80A20	DIESEL	-.0297500	.0291145
	D90A10	.0027500	.0291145
	D70A30	-.0097500	.0291145
D70A30	DIESEL	-.0200000	.0291145
	D90A10	.0125000	.0291145
	D80A20	.0097500	.0291145