Influence of Exhaust Gas Recirculation on Emission Characteristics of Diesel Blended With Waste Cooking Oil

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***Abstract* – Biodiesel has become the best alternative fuel compared to conventional diesel in the present scenario. It can be extracted from various resources, such as animal fats, vegetable oil and even from waste cooking oil .The largest available sources of oils comes from different crops such as soya bean, sunflower, palm, ripe seed, honge, and jatropa. The extraction of oil from crops may slightly affect the food production. Due to depletion of fossil fuels, Biodiesel could be one of the best alternatives for the fuels. Most of the biodiesel is produced from edible oilseeds and various vegetable oils like palm oil, soya bean, and sunflower etc. Biodiesel are preferred because of their characteristics such as good performance as compared to diesel and less emissions. The present work includes the study of emission characteristics of a biodiesel which was prepared from waste cooking oil (WCO). The results obtained are compared with the results of conventional diesel as fuel and found almost nearer to the conventional fuel. The emissions of NOx with the Biodiesel as a fuel are found to be less compared to the conventional Diesel fuel. Hence more focus is kept on the reduction of NOx emissions. This is best reduced by introducing the concept of EGR (Exhaust gas recirculation) in the engine performance test.**

***Keywords:* Waste Cooking Oil, Biodiesel, Transesterification, EGR, NOx.**

I. INTRODUCTION

Vegetable oil converted to methyl-esters or ethyl-esters are commonly referred to as "biodiesel". Fuels derived from bio-oils are the prominent sources as alternative diesel fuels. Depletion of fossil fuels and comparatively less pollution of biodiesel to that of diesel fuel has been the reason to use products of vegetable oil. Technically biodiesel is competitive conventional diesel fuel. By the method of trans-esterification vegetable oils can be converted into useful bio-fuels in the presence of a catalyst. Trans-esterification process is used to convert vegetable oils to methyl esters, ethyl esters, 2-propyl esters, and butyl esters using KOH or NAOH as catalysts. The process is used to reduce the viscosity of the vegetable oil. Vegetable oils have large branch molecule structure, if they are to be used in diesel engine; we have to convert them to small straight molecules. This can be done by trans-esterification and it is a less effective method compared to other methods. Biodiesel fuel consumes more fuel which results in lower torque and power as compared to diesel fuel. Biodiesel has few properties such as flash point and fire point, sulfur content, aromatic content, and biodegradability considerable good. Without any modification to the existing engine, biodiesel can be used as fuel and is environmentally friendly.

Diesel is a non-renewable resource. As per the present condition the usage of fossil fuel has been increased rapidly. So, in a few decades these fossil fuels may be utilized completely. In order to decrease this situation, there is a need to think of alternative energy resources. One such energy resource is BIODIESEL. Biodiesel can be extracted from various resources, such as animal fats, vegetable oil and even from waste cooking oil. The largest available sources of oils come from different crops as soya bean, sunflower and so on. The preparation cost of biodiesel is less when compared to fossil fuel. Biodiesel has many environmental benefits over fossil fuels. The emissions of Nitrogen oxides (NOx) are high when fossil fuels are used. To lower the Nitrogen Oxides (NOx) in the combustion chamber EGR technique is the most preferable technique

II. LITERATURE SURVEY

An extensive literature survey is made on the work of the various biodiesels prepared from various feedstocks. Many papers in review have described the effect of biodiesel on the performance characteristics of biodiesel over conventional diesel. It can be observed the emission is slightly more compared to conventional diesel as studied from various experiments conducted which can be understood from the literature survey. Concerns to address these issues have led to research on renewable fuels and their utilization for compression ignition engine applications. This renewed interest in engine research and development of internal combustion engines in general and diesel engines in particular with capability of meeting the emission norms of Bharat stage and EURO norms is the need of the hour. Biodiesel and ethanol can be produced from various feed-stocks that are generally considered to be renewable. Studies on use of biodiesel in diesel engines have reported reduction in emission and a slight improvement in thermal efficiency.

III. EXPERIMENTAL SET UP

The below fig. 1 shows the experimental set up of 4-s single cylinder diesel engine where biodiesel can be tested. The specifications of the engine are mentioned above. The test on this set up is made for the different percentage of EGR. The arrangements have been made to recycle the exhaust gas, to analyze the effect of it on emission. The dynamometer is used for giving the different loads. A computer arrangement is made to display the readings during the tests. Various parameters like Break power, Indicated power, Break mean effective pressure, Mechanical Efficiency, Specific fuel consumption, Thermal efficiency, A/F ratio and other parameters for emission analysis have been calculated.

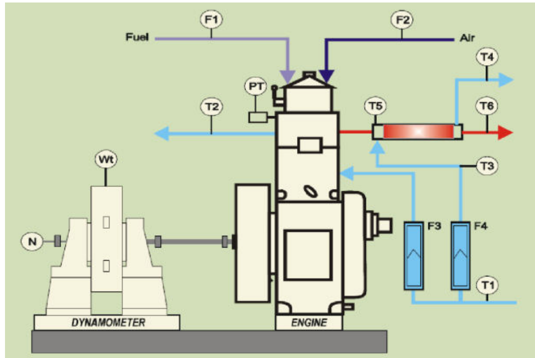

Fig 1. Experimental Setup

ENGINE SPECIFICATION:

1. ENGINE : 4 STROKE SINGLE CYLINDER DIESEL ENGINE
2. FUEL : DIESEL, BIODIESEL
3. POWER : 5.5 KW
4. SPEED : 1450 RPM
5. BORE : 86.5 MM
6. LENGTH OF STROKE : 111MM
7. CONNECTING ROD LENGTH : 235MM
8. COMPRESSION RATIO : 17.50
9. SWEPT VOLUME : 661.45 CC
10. COOLING SYSTEM : WATER COOLED
11. TEMPERATURE MEASUREMENT: DIGITAL THERMOCOUPLE

IV. RESULT AND DISCUSSION

LOAD %	UHC PPM	CO %	CO_2 %	NO_X PPM
0	14	0.029	1.79	165
25	18	0.004	3.75	747
50	22	0	5.45	1229
75	29	0.01	7.10	1985
100	42	0.15	9.63	2162

Table 1. Emission Characteristics of Diesel

LOAD %	UHC PPM	CO %	CO_2 %	NO_X PPM
0	5	0.057	2.05	128
25	5	0.015	4.05	635
50	5	0.002	5.77	1313
75	4	0.011	7.55	1809
100	18	0.114	10.1	2121

Table 2. Emission Characteristics of WCO at 0% EGR

LOAD %	UHC PPM	CO %	CO_2 %	NO_X PPM
0	5	0.06	2.11	118
25	0	0.009	4.24	590
50	1	0.004	6.04	1185
75	6	0.024	8.03	1485
100	25	0.293	10.7	1515

Table 3. Emission Characteristics of WCO at 10% EGR

LOAD %	UHC PPM	CO %	CO_2 %	NO_X PPM
0	13	0.115	2.37	98
25	19	0.05	4.55	548
50	25	0.053	6.38	1029
75	34	0.081	8.60	1245
100	61	0.740	11.6	1150

Table 4. Emission Characteristics of WCO at 15% EGR

LOAD %	UHC PPM	CO %	CO_2 %	NO_X PPM
0	12	0.092	2.49	80
25	18	0.056	4.74	551
50	22	0.055	6.73	972
75	33	0.096	9.12	1083
100	82	1.455	12	860

Table 5. Emission Characteristics of WCO at 20% EGR

The above experiments are conducted for the load of 0%, 25%, 50%, 75%, and 100%. Table I shows the emission characteristics of diesel for 0% of EGR. Table II, shows the emission characteristics of Biodiesel (WCO) for 0% of EGR. Table III, shows the emission characteristics of Biodiesel (WCO) for 10% of EGR Table IV, shows the emission characteristics of Biodiesel (WCO) for 15% of EGR Table V, shows the emission characteristics of Biodiesel (WCO) for 20% of EGR The emission characteristics are tabulated in above table. The graphs for the different percentage of EGR is tabulated below

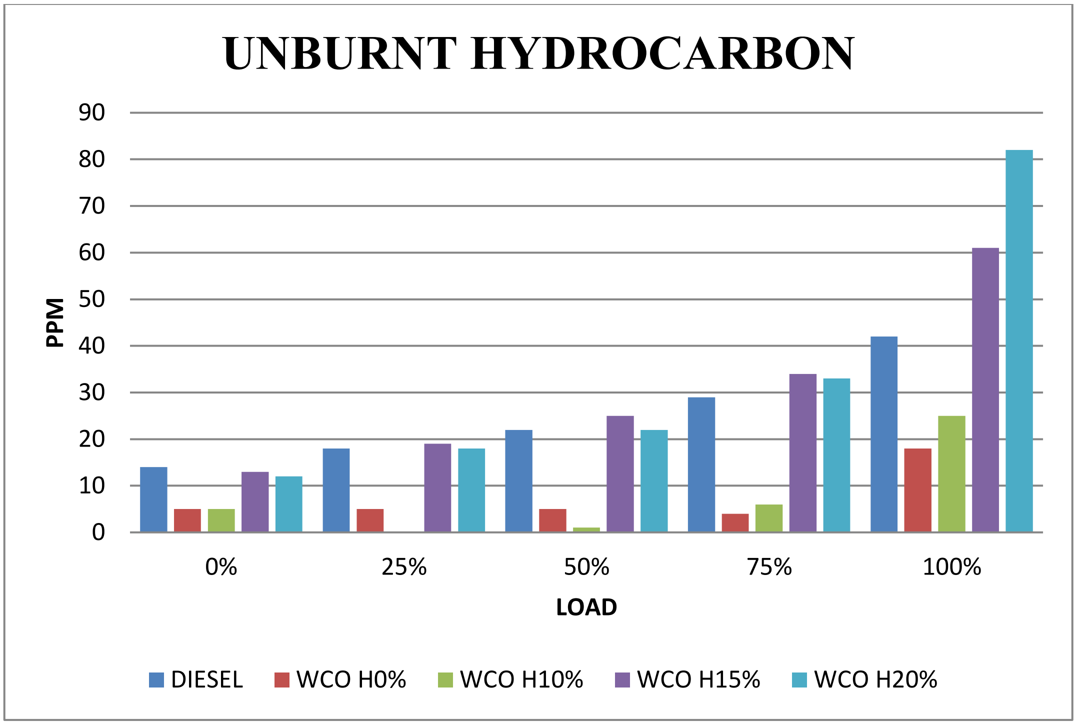

Fig 2. Load vs Unburnt Hydrocarbons

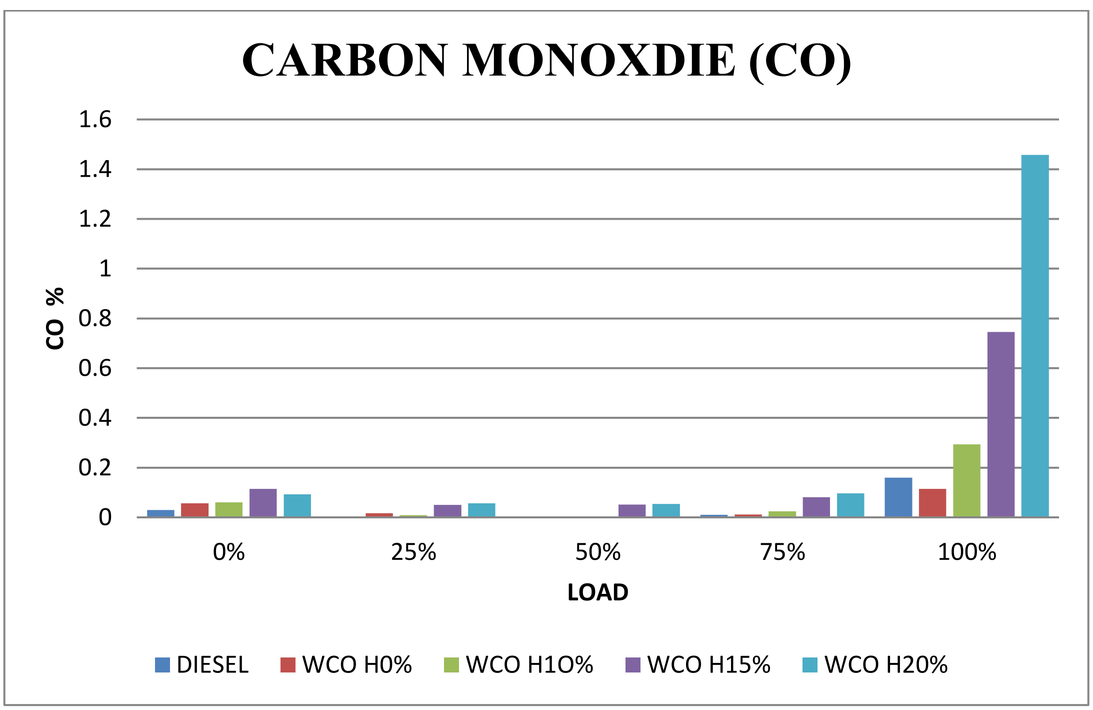

Fig 3. Load vs Carbon Monoxide

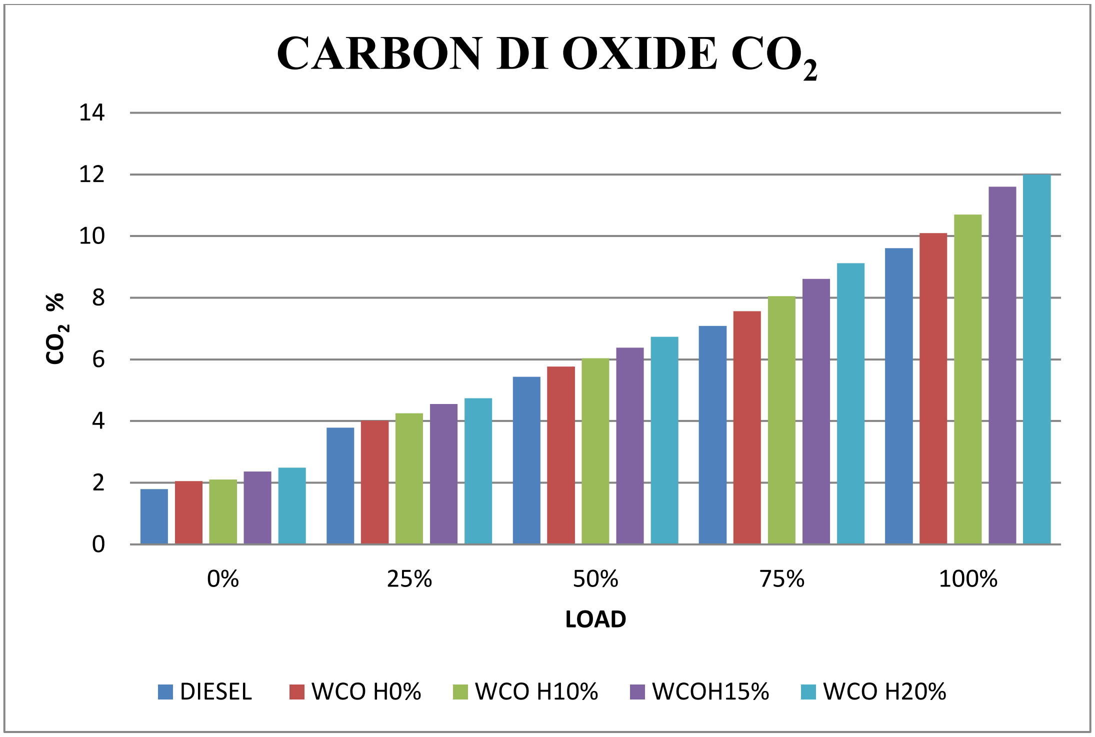

Fig 4. Load vs Carbon Dioxide

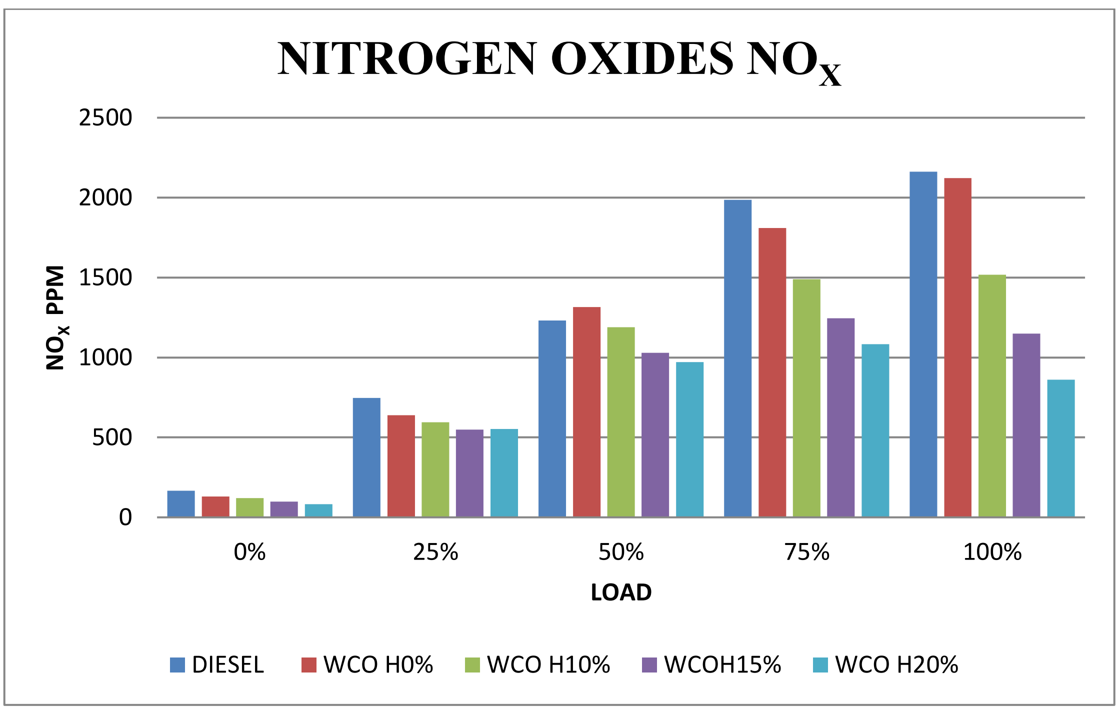

Fig 5. Load vs NOx

The incomplete combustion results in the formation of unburnt hydrocarbons. Fig. 2, shows the formation of hydrocarbons for different loads. The amount of hydrocarbons in the emission decreases with an increase of % of EGR. When compared to diesel, biodiesel has less hydrocarbon emissions when the EGR technique is adopted. Formation of less unburnt hydrocarbons in Bio diesel (WCO) is due to the high cetane number and more gas temperature as compared to conventional fuel like diesel. As the cetane number increases, ignition delay reduces and hence there is a reduction of hydrocarbon emission.

Fig. 3 Shows Carbon monoxide which is an odourless, colourless and slightly toxic and it is emitted due to combustion of fuel. It was observed that CO is the same with an increase of % of EGR. CO emission for 100% EGR shows a slight increase.

Fig. 4 shows the incombustible gas carbon dioxide, which is colourless and odourless, has formed during the combustion process. Carbon dioxide emission is slightly more as compared to the diesel emission and not much effect even EGR is adopted

Fig. 5 shows variation of Nitrogen oxides (NOx) with increase in load. NOx shows a slight increase as the load increases. But with the introduction of EGR it is observed there is a reduction of emission.

Further emissions are reduced by introducing a technique Exhaust Gas Recirculation (EGR)

V. CONCLUSION

Experiments were conducted for the different percentage of EGR by varying the load, it can be concluded that when it is compared to diesel, biodiesel (WCO) is more efficient in performance and also contributes to the reduction in emission also. When the emissions are considered, the most affect parameter is nitrogen oxides, this is slightly more in biodiesel and hence by adopting EGR techniques, nitrogen oxides can be reduced considerably.

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