Investigation on Effect of Exhaust Gas Recirculation system on Jatropha Bio-Diesel in Diesel Engine

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Abstract-- A Diesel engine is running on biodiesel is found to transmit higher oxide of nitrogen. The current investigation was to consider the impact of Fumes Gas Distribution (an EGR) on the diesel engine. Fumes gas distribution is the most generally utilized technique for controlling and decreasing outflows, especially nitrogen oxide (NOx), CO, and CO2. EGR is a framework where some rate measure has of the exhaust gases re-coursed into the ignition chamber utilizing the admission complex. Diesel is the fundamental transportation fuel in India, giving a relatable option in a contrast to diesel is a pressing need. Jatropha-based bio-diesel is a non-palatable, inexhaustible fuel reasonable for diesel engines and getting expanding center in India as of its capability to produce bigger business and low natural debasement. The current work is an endeavor to biodiesel and depletes gas distribution framework, which is pre-treatment procedure, for diesel motor to lessen oxides of nitrogen is picked for present work. (NOX) is decreased when utilizing EGR for each situation. The outcome shows that the worth of CO and CO_2 diminished insignificantly.)

Keywords-- *Jathropha bio diesel, EGR system, C I ENGINE*

I. INTRODUCTION

A. Introduction of Bio diesel

Biodiesel is an elective fuel produced using sustainable organic sources, for example, vegetable oils both (palatable and non-consumable oil) and creature fats. Vegetable oils are typically esters of glycol with various chain lengths and levels of immersion. It could be seen that vegetable contains a generous measure of oxygen in their atoms [14].

B. Use of Jatropha in Diesel Engine

Indian researchers, market analysts, and government officials have gotten progressively keen on Jatropha, a plant that fills in dry or semi-dry tropical locales and produces seeds containing anyplace between 21% to 48% oil. It is guessed that Jatropha could be the response to the food-versus-fuel banter since it develops on negligible land or around crops as defensive boundaries without rivalling them for regular assets. Bio fuel improvement in India bases basically on the development and preparation of Jatropha plant seeds which are extremely wealthy in oil (40%). The drivers for this are noteworthy, useful, financial, natural, moral, and political. Jatropha oil has been utilized in India for quite a few years as biodiesel for the diesel fuel necessities of far-off country and backwoods networks; Jatropha oil can be utilized straightforwardly after extraction (for example without refining) in diesel generators and engines. Jatropha can give monetary advantages at the nearby level since under appropriate administration it can fill in dry peripheral non-horticultural grounds, accordingly permitting locals and ranchers to use non-ranch land for money age. Also, expanded Jatropha oil creation conveys monetary advantages to India on the macroeconomic or public level as it lessens the country's petroleum derivative import bill for diesel creation (the primary transportation fuel utilized in the country. What's more, since Jatropha oil is carbon-impartial, huge scope creation will improve the country's fossil fuel bioproducts profile. Enormous plots of no man's land have been chosen for Jatropha development and will give truly necessary work to the rustic poor of India. Organizations are likewise considering the to be of Jatropha as a decent business opportunity. The Public authority of India has recognized 400,000 square kilometres (98 million sections of land) of land where Jatropha can be developed, trusting it will supplant 20% of India's diesel utilization by 2020. The creation of biodiesel is restricted via land territory yet Jatropha curcas trees can be developed on any sort of land. Jatropha is a fiercely developing tough plant, in bone-dry and semiarid areas of the country on corrupted soils having low richness and dampness. It tends to be developed effectively in the districts having insufficient to hefty precipitation even it tends to be developed even on decrepit and fruitless terrains. There is a gigantic unused region in the southern piece of Bangladesh, where Jatropha can be developed with productive pay. The seeds of Jatropha contain 50-60% oil. So, India can deliver a colossal measure of biodiesel from Jatropha cruces and can save a lot of bringing in oil-based goods from unfamiliar nations. A Jatropha motivation in India is a piece of India's objective to accomplish energy freedom constantly 2012. Jatropha oil is created from the seeds of the Jatropha cruces, a plant that can fill in Badlands across India, and the oil is viewed as an amazing wellspring of bio-diesel. India is enthusiastic about diminishing its reliance on coal and petrol to fulfil its expanding energy need and empowering Jatropha development is a significant segment of its energy strategy [15].

C. Exhaust Gas Recirculation

EGR is a strategy for NOx control that has progressively gotten exceptionally successful and is broadly utilized in the control and decrease of NOx outflows couple with other NOx control frameworks. The framework works by recycling a part of the exhaust gases into the ignition chamber for consumption along with the new admission charge. Since NOx is a temperature-subordinate capacity, EGR's principal work, thusly, is to decrease the ignition temperatures gases for a given mass of fuel and oxygen that is scorched in the burning chamber. In any case, while it is viable as an action to control NOx discharges, it has negative marks since it will, in general, expand CO and PM outflows, consequently restricting the degree to which it tends to be applied and recycled, to about 30% [16].

II. METHODOLOGY

A. Experimental setup and Methodology

In this arrangement taken one diesel engine, particularly given in table 3.1, this engine served cooling framework as air-cooled, first and foremost outlining as indicated by the size of the engine. Through metal angle and joint by utilizing cathode welding. After putting an engine on the edge following stage to arrange different frill on the casing, for example, rope dynamometer, gas tank, burette, and so on. pully was welded at the yield shaft of the engine and set dynamometer on this pulley. rope brake dynamometer having a limit of 10 to 100kg, yet set in 20kg burden (which are fix in all investigations) condition with spring pressure. By utilizing a tachometer set diverse rpm reaches to changing situation of speed increase wire. Estimating fuel utilization utilizing burette tube associated with the fuel injector. Presently arranging EGR tube, create the bore of this tube in lathe machine to concurring the prerequisites and fitted among exhaust and inlet, which are given hot gases from to the exhaust to the inlet in a few sums. What's more, ultimately estimating emanation of gases temperature by infrared thermometer and fumes gas outflow like CO, NO, NOx, utilizing of the gas analyzer.

Table 1: Engine Specification

Parameter	Specification
Number of cylinders	Single cylinder
Number of strokes	4 strokes
Fuel type	Diesel
Displacement	435 cc
Maximum power	6 KW @ 3600rpm
Maximum Speed	3600 rpm
Maximum torque	21 N.n @ 2000-2400 rpm
Weight	50 Kg
Technical feature	Aluminium head & crank case
	2 valve / cylinder
	Natural aspired
	Air cooled diesel engine
	BS IV emission compliant

B. EGR SETUP

III. EXPERIMENTAL PROCEDURE AND INVESTIGATION

The examination will finish on a single chamber, air-cooled, and four-stroke diesel engine. In this preliminary taken data with different conditions, for instance, conventional conditions using diesel,10%JBD-90%D, and 20%JBD-80%D. The engine will at first start and be kept in running condition for up to 10 minutes. At the point when it arrived at its steady condition. Starting now and into the foreseeable future, we will set the speed of the engine as 600 rpm (Tachometer was used) with a fixed weight condition of about 20kg set in the dynamometer. At the point when rpm set, we will see the time by stopwatch required by the engine to consume 20 ml of fuel, and thereafter the Temperature at the Ventilation framework will measure with the help of an infrared Thermometer or Thermocouple. Assessments for different limits (BP, FC, SFC, BSFC, BTE, etc) will figure by got time and temperature. The assessments will moreover be finished by setting the speed of the engine as 1200, 1800, 2400, 3000 rpm with the same weight condition and the time required by the engine to eat up 20 ml of fuel and vapor gas temperature will be assessed. The huge differentiation of assessment of time and temperature between various rpm was around 10 minutes for instance, after each assessment, the engine will be kept in running condition up to approximately 10 minutes and a while later time and temperature will figure and further calculations of various limits will be done. finished above attempt in 3 stages, at first taken examining in 100%D without and with EGR with different rpm ranges, after that using 10%JBD-90%D without and with EGR in a couple of rpm ranges, and at last change into the fuel condition to 20%JBD-80%D without and with EGR in a couple of rpm ranges. From here on out, taking a gander at all results and wrap up the ideal result. With the record of discharge boundaries like CO, NO, NOx emanation.

IV. RESUALT AND DISCUSSION

A. Performance and Emission reading

Table 2: Sample of Performance reading

100% Diesel for normal condition

RPM	B.P (KW)	FC (kg/hr)	SFC (Kg/kw-hr)	BSEC (KJ/kw-hr)	BTE (%)	Time (sec)
600	1.16	0.46	0.40	16463.58	21.87 %	136
1200	2.32	0.65	0.28	11541.48	31.19 %	97
1800	3.47	0.84	0.24	9951.32	36.18 %	75
2400	4.63	0.99	0.21	8885.11	40.52 %	63
3000	5.79	1.14	0.20	8141.99	44.22 %	55

10% Biodiesel without EGR

RPM	B.P (KW)	FC (kg/hr)	SFC (Kg/kw-hr)	BSEC (KJ/kw-hr)	BTE (%)	Time (sec)
600	1.16	0.48	0.42	17223.44	20.90 %	130
1200	2.32	0.63	0.27	11308.32	31.83 %	99
1800	3.47	0.89	0.26	10662.13	33.76 %	70
2400	4.63	1.06	0.23	9487.49	37.94 %	59
3000	5.79	1.18	0.20	8449.23	42.61 %	53

20% Biodiesel without EGR

RPM	B.P (KW)	FC (kg/hr)	SFC (Kg/kw-hr)	BSEC (KJ/kw-hr)	BTE (%)	Time (sec)
600	1.16	0.526	0.454	18815.522	19.13 %	119
1200	2.32	0.653	0.282	11661.704	30.87 %	96
1800	3.47	0.895	0.258	10662.129	33.76 %	70
2400	4.63	1.119	0.241	9995.746	36.02 %	56
3000	5.79	1.253	0.216	8956.189	40.20 %	50

10% Biodiesel with EGR

RPM	B.P (KW)	FC (kg/hr)	SFC (Kg/kw-hr)	BSEC (KJ/kw-hr)	BTE (%)	Time (sec)
600	1.16	0.513	0.443	18352.845	19.62 %	122
1200	2.32	0.659	0.285	11784.459	30.55 %	95
1800	3.47	0.908	0.261	10816.653	33.28 %	69
2400	4.63	1.099	0.237	9820.382	36.66 %	57
3000	5.79	1.228	0.212	8780.577	41.00 %	51

20 % Biodiesel with EGR

RPM	B.P (KW)	FC (kg/hr)	SFC (Kg/kw-hr)	BSEC (KJ/kw-hr)	BTE (%)	Time (sec)
600	1.16	0.513	0.443	18352.845	19.62 %	122
1200	2.32	0.674	0.291	12037.888	29.91 %	93
1800	3.47	0.949	0.273	11308.319	31.83 %	66
2400	4.63	1.228	0.265	10975.721	32.80 %	51

3000	5.79	1.362	0.235	9734.988	36.98 %	46

Table 3- sample Emission reading

100% Diesel for normal condition

RPM	HC	CO	CO2	O2	NOx PPM	EGT C
600	58	0.84	2.89	14.49	430	120
1200	65	0.87	2.91	14.41	468	131
1800	74	0.88	2.91	14.39	483	138
2400	85	0.9	2.94	14.41	491	143
3000	93	0.9	2.96	14.4	504	149

10% Biodiesel without EGR

RPM	HC	CO	CO2	O2	NOx PPM	EGT C
600	56	0.86	2.91	14.42	433	123
1200	64	0.86	2.92	14.4	472	132
1800	74	0.9	2.94	14.44	488	141
2400	83	0.91	2.95	14.43	494	145
3000	92	0.9	2.97	14.44	510	151

20% Biodiesel without EGR

RPM	HC	CO	CO2	O2	NOx PPM	EGT C
600	56	0.87	2.92	14.51	437	125
1200	63	0.89	2.91	14.53	476	133
1800	72	0.89	2.92	14.5	495	141
2400	83	0.88	2.91	14.49	501	147
3000	91	0.89	2.93	14.53	517	152

10% Biodiesel with EGR

RPM	HC	CO	CO2	O2	NOx PPM	EGT C
600	60	0.8	2.9	14.49	406	117
1200	67	0.83	2.94	14.41	418	123
1800	75	0.83	2.94	14.39	424	132
2400	87	0.82	2.96	14.41	433	136
3000	94	0.84	2.94	14.4	441	148

20% Biodiesel with EGR

RPM	HC	CO	CO2	O2	NOx PPM	EGT C
600	63	0.78	2.92	14.5	410	119
1200	68	0.81	2.92	14.49	429	124
1800	77	0.81	2.96	14.42	440	134
2400	90	0.79	2.95	14.42	453	139
3000	94	0.8	2.94	14.43	458	150

4.2 Sample calculation

Data- weight=20kg,Spring stiffness=1.2

Diameter of pulley=200mm,RPM=600

(W-S)=18.8kg

(W-S)=18.8*9.81=184.42

1. Brake power = $\dfrac{\Pi DN(W-S)}{60 * 1000}$ (KW)

Brake power = $\dfrac{3.14 * 0.20 * 600 * 184.428}{60 * 1000}$

B. P= 1.158(KW)

2. Fuel consumption (kg/hr)

Fuel consumption = $\dfrac{Mf * 3600}{Time * 1000}$ * specific gravity

Fuel consumption = $\dfrac{72000}{136000}$ * 0.87 =

FC= 0.4605 (kg/**h**

3.Specific fuel consumption (Kg/kw-hr)

SFC = $\dfrac{\text{Fuel Consumption}}{\text{Break Power}}$ (Kg/KW-hr)

$\dfrac{0.4605}{1.158}$ = 0.3976 (Kg/KW-hr)

. Brake thermal efficiency (%)

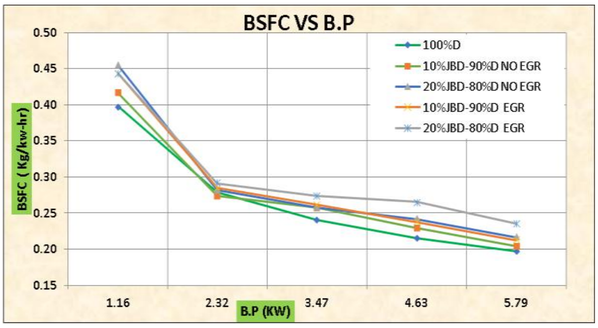
BTE = $\dfrac{B.P * 3600}{FC * Cv}$ *** 100**

$$BTE = \frac{1.158 * 3600}{0.4605 * 41400} * 100 = \frac{4168.8}{19064.7} * 100$$

BTE= 21.86 %

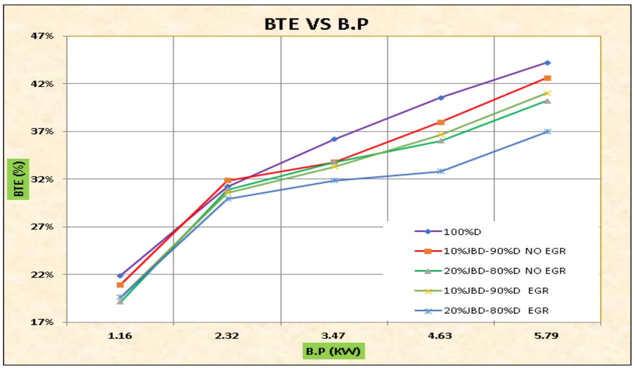
4.3 Performance Characteristic

Brake Specific Fuel Consumption VS Brake Power



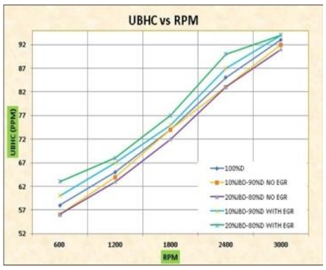
The brake-specific fuel utilization is the fuel stream rate per unit of power output. It is an amount of the effectiveness of the engine in utilizing the fuel provided to deliver work, fig 6.1 shows that adjustment of the BSFC with the distinctive mixing of JBD with the diesel and with utilizing EGR. At the steady load condition about 20kg and variable rpm range. It tells that the particular fuel utilization of the diesel with individual mixes seen an abatement with an increment in brake power. Moreover, fuel utilization shows an increment alongside a high extent of biodiesel in the mix and applying EGR. The BSFC of all fills with a brake power of 3.47 kW were as the accompanying 0.24 kg/kW-hr for Diesel fuel, 0.26 kg/kW-hr for 10%JBD-90%D without EGR, and for 20%JBD-80%D with EGR 0.27 kg/kW-hr. shows the least at 100%D with 5.79 kW brake power discovered 0.20 kg/kW-hr and 20%JBD-80%D EGR having a similar brake power getting 0.24 kg/kW-hr which has higher. Contrasting the BSFC boundary and higher mixes of biodiesel against pure diesel; biodiesel has a higher consistency and burning occurred at lower RPM which demonstrates high mass utilization per unit power output. As the RPM builds the increment of temperature has been noticed, which turns down the result of the great consistency of the mixes of biodiesel and accordingly BSFC of mixes of biodiesel shows up very nearer to pure diesel.

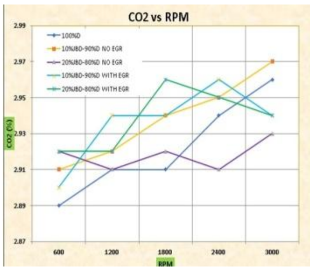
Brake thermal efficiency VS Brake Power

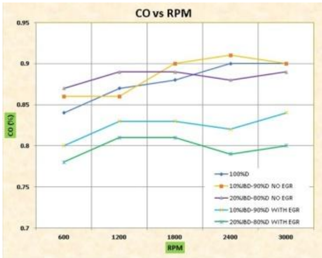


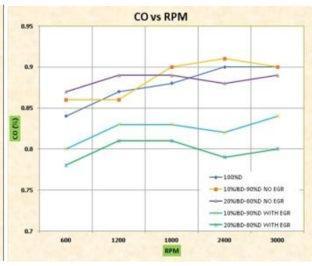
BTE shows the connection between the output in power and given energy as fuel. It can likewise be expressed as the result of the flow rate of the mass of fuel infused and the lower heating worth. With the Jatropha biodiesel, its mixes, and utilizing of EGR, BTE shows variety with change in speed. It shows that when break power esteem is increment BTE additionally an expansion in pure diesel and all the bland of jatropha biodiesel with and without utilizing of EGR. In the examination BTE of 10%JBD-90%D without EGR and 20%JBD-80%D with EGR were 33.76% and 31.83% contrast with pure diesel (36.18%) at the 3.47 kW brake power. At higher mixes of biodiesel and utilizing EGR, it is seen that BTE slides down somewhat because of the greater consistency and lower heating value of biodiesel. BTE for Jatropha biodiesel 33.76% when utilizing EGR at the time 31.38% at 3.47kw brake power.

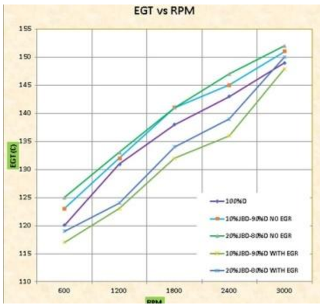
4.4 Emission Characteristic











HC VS RPM

Fig 6.3 shows the emanation of unburned hydrocarbons with the progressions of rpm, It was delineated that jatropha biodiesel has the most noteworthy pace of discharging UBHC with almost when contrasted with pure diesel. while working with EGR because of the decrease of oxygen in the inlet charge, EGR builds the UBHC discharges for the biodiesel all rpm range. With EGR the oxygen accessible for ignition is decreased and the air-fuel blend doesn't combust as expected coming about in higher UBHC emanations. Fig 6.3 shows that when utilizing biodiesel UBHC lower than pure diesel yet when utilizing biodiesel with EGR then its increments than the pure diesel, with an expansion of rpm UBHC additionally increments because of deficient ignition. UBHC varies from 58 with diesel to 63 ppm for 20%JBD-80%D WITH EGR, which shows that the increase in the UBHC when using EGR with biodiesel. 20%JBD-80%D WITH EGR having higher value to the absence of oxygen.

CO_2 VS RPM

Effect of EGR and biodiesel on CO2 are shown in figure. The graph shows that CO2 emissions level at low RPM increased and at high RPM CO2 emissions decreased. In case of Jatropha biodiesel 20% and diesel 80% CO2 first increase and at high RPM decreased

CO VS RPM

In comparison, the percentage of CO emission for diesel fuel has linearly increased overall due to increasing engine speed (figure 6.5) While in jatropha biodiesel, it is found that CO emission has increased higher than the pure diesel corresponding with the increasing engine speeds under without EGR mode. Percentages of CO emission from jatropha bio-diesel were lower than diesel when operating with EGR due to some of the oxygen present in the inlet charge is replaced with recalculates exhaust gas that causes incomplete combustion. Furthermore, the increasing cetane number in jatropha bio-diesel helps to reduce the CO concentration in the exhaust piping. These experiments found that percentage of CO emission is reduce when using 20%JBD-80%D WITH EGR and found higher co emission at 10%JBD-90%D NO EGR when this engine runs at 2400 rpm.

NOx VS RPM

shows the NOx outflows at different RPMs for the fuel tried with and without EGR contrasted with diesel. NOx discharges are decreased for the jatropha biodiesel mixes and utilizing EGR. This is because of the reality with EGR the accessibility of oxygen decreases; moreover, the higher specific heat capacity of the re-circled exhaust gases brings down the temperature in the combustion chamber and the flame temperature, which consequently lessens the response rates prompting the development of NOx outflows. At evaluated rpm, the NOx emission change from 430 to 504 ppm in pure diesel when the engine running without EGR. On account of 10%JBD-90%D without EGR can differ to changes low rpm to high separately 433 to 510 ppm yet when we use EGR in a similar condition with high rpm it's low from 510 to 441 ppm. Be that as it may, when utilizing 20%JBD-80%D without EGR 517 ppm is the high worth at max 3000 rpm, and in the wake of utilizing EGR, it's down to 458 ppm. Since the decrease in ignition temperature while utilizing EGR the creation of NOx is diminished

EGT VS RPM

shows the relation between exhaust gas temperature with changes in rpm, in that when using pure diesel, the temperature is placed at between the 10%JBD and 20%JBD line but when using EGR its changes to lower. At the 2400 rpm 143 ̊C found to using pure diesel when using biodiesel without EGR it becomes 147 ̊C, but when using EGR in biodiesel bland it becomes low from 147 ̊C to 139 ̊C. When increasing rpm all bland and also diesel with and without EGR comes closer and minimum changes present from 149 ̊C to 152 ̊C.

CONCLUSION

By experimental setup to measure the effect of exhaust gas recirculation on engine performance characteristics like as exhaust gas temperature, brake specific fuel consumption, thermal efficiency and emissions characteristics like as Hydro carbon, Carbon monoxide, carbon dioxide, Nitrogen oxide has been developed. the following conclusions can be drawn from the experimental results.

1. Brake thermal efficiency marginally decreased with EGR. 10% biodiesel with EGR is good result as compared to 20% biodiesel with EGR.
2. brake specific fuel consumption increases marginally with increasing exhaust gas recirculation system
3. the value of exhaust gas temperature is decreased with EGR system
4. NOx level reduced with EGR. Higher NOx level can be effectively controlled by employing EGR
5. The value of HC is increases with EGR
6. The rate of CO is reducing with EGR system.
7. From the experimental study, it can be suggested 10% biodiesel with EGR NOx level is lower and brake thermal efficiency also good

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