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Performance Effect Of EGR On CI Engine Vibrations

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Abstract: The increase in world population leads to the growth in energy demand. The primary sources of this energy come from the combustion of fossil fuel which producing oxides of nitrogen and other harmful greenhouse gas emission. However, biodiesel offers a solution as an alternative fuel for internal combustion engine but higher in NOx emission. Exhaust gas recirculation (EGR) system is used to lower the NOx emission. In this project we test the four stroke water cooled diesel engine to check the effect of different parameters such as % of blend, CR.EGR rate, injection temperature on the performance, emission and vibration characteristics of engine. This experimentation shows The exhaust temperature is increased while the BSFC, emission indices CO_2, CO decreased with an increased of engine speed. Also, in particular, biodiesel produced with the addition of the per oxidation process had the lowest equivalence ratio and emission indices of CO, CO. This evaluates the performance and emission for different EGR rates of the engine.

Keywords: *Compression Ratio, EGR Rate, Infection Pressure, Percentage Blend, Vibration*

I. INTRODUCTION

During the past decades word wide petroleum consumption has permanently increased due to the growth of human populations and industrialisations. This has caused depleting fossil fuel reserves and increasing petroleum price. The combustion of fossil fuels contributes most to emission of green house gases, which leads to atmospheric solutions and global warming. There for the great awareness in diesel fuel substitutions at the present all over the world with a clean, renewable fuels such as biodiesel, which has lot of technical advantages over fossil fuels such as lower overall exhaust emission and lower toxicity, biodegradability. This biodiesel could be used as pure fuel or as a blend with petro-diesel which is stable in or ratios.[1] Types of feedstock for production of biodiesel can be traditionally categorized in to three main groups: vegetable oils (edible and non edible) , animal fats and waste cooking oils (oily materials), algal oils etc. in vegetable oils we mostly used the non edible oils because of the higher prices of edible oils than that of fossil fuels and the lower cost of non edible plant oil cultivations. Also, animal fats such as tallow, white grease or lard, chicken fat are favourably used for conversion for biodiesel. But, it is the fact that animal fats can create a big problem during the biodiesel production since, they became solid wax at room temperature [31]. Waste cooking oils could be the good choice as feed stock for biodiesel production. The conversion of the waste cooking oils in to alkyl esters is done by trans esterification process. As waste cooking oils can contaminated by many types of impurities. So their conversion in to biodiesel is complicated.[1] The biodiesel production process is a reactions between triglycerides in the vegetable an alcohol which produces the biodiesel and glycerol.[6][2] in this process some catalyst are also used to increase the speed of the reaction and quality of outcome product. The amount and type of catalyst are decided by the amount of free fatty acids present in the feed stock oils. The higher amount of free fatty acids is unfavourable for biodiesel productions.[7-8] [2]. The experimentations show that the fuel consumption rate, brake thermal efficiency, and exhaust temperature is increased while the BSFC, emission indices CO2, CO decreased with an increased of speed. Also, in particular, biodiesel produced with the addition of the per oxidation process had the lowest equivalence ratio and emission indices of CO2.CO. Also, this evaluates the performance and emission for different EGR rates of the engine. The thermal efficiency is found to have slightly increased with EGR at lower engine loads BSFC is lower at lower loads for engine operated with EGR from compared to without EGR. However, at higher engine loads, BSFC with EGR is almost similar to that of without EGR. Exhaust temperature drops with increase in EGR rate. The reason of the temperature are less availability of oxygen and higher specific heats of recalculated and fresh air mixture. However, HC and CO emission are increases with increasing EGR. HC and CO emission increases due to lower oxygen concentration which results in rich air-fuel mixtures and incomplete combustion. The degree of reduction in NOx at higher loads is higher. The reduction in NOx emissions using EGR is observed due to oxygen concentrations and decreased flame temperature in the combustible temperature. At the part load, O2 is available in sufficient quantity but at high loads, O2 reduces drastically, therefore NOx reduction is more at high loads compared to low loads.[1]

II. LITERATURE SURVEY

`Ivana B.Bankovic-llic(2012)et.al. studied that the biodiesel is mainly produced from vegetable oils by transesterification process. But he replaced the edible oils and used non-edible plant oils instead of edible oils. He concluded the possibilities of the use of non-edible oils into biodiesel production to consider various methods for treatment of non-edible oils and finally he observed the possibilities of optimizations, kinetics and improper of biodiesel production from non-edible oils. [2]

A. Rajalingam ,(2016) et.al. studied that the properties of vegetable oils/animal fats by using generally four methods are used to produced biodiesel from vegetable oils and animals fats. The biodiesel production method such as direct used the and blending transesterification process, pyrolys , and micro-emulsion. At that time he considered the in the production of biodiesel such as cost, property, production methodology, required equipment. After the finally he concluded that the by using a process of transesterification will give a better fuel quality and efficiency. It also get by product of a process it can be used for some other required applications which will reduced overall production cost.[1]

Daming Huang (2012) et.al. studied that and observed that different types of biodiesel, its characteristics, processing and economics of biodiesel industry, application of biodiesel in automobile industry and challenges biodiesel industry. He concluded that as the biodiesel % increases beyond the limit, emission level increases. Also, non-edible oils are preferred than the edible oils[3].
Venkata Ramesh Mamilla (2013) et.al. studied that petroleum resources are limited and consumption rate is increasing very fast. The emission from petroleum products pollute the environment. They took the jatropha oil for the purpose of renewable energy source. They investigate the percentage substitution of jetropha methyl ester blends to the diesel as fuel for automobile. Finally they concluded the 20% of blend shows better performance with reduced pollution they analysis shows that jatropha methyl ester blended biodiesel is a good substitute for pure diesel. [4].

Wail M.Adilch and Khaled S.Alqdah (2012) observed the emission of NOx increased by using B5 and B20 instead of pure diesel. They done the experimental results compared with standard diesel show that biodiesel reduces the CO, HC but NOx was increased. They concluded that per oxidation process can be used effectively to improved the fuel properties and reduced the emission when biodiesel.

G.A.Nagargoje (2016) et.al. studied that biodiesel is obtained from vegetable oils though the transesterification process which are leads to high NOx emissions. They used the EGR technique for the purpose of reduction of NOx emissions. Finally they concluded that the EGR is very useful method for dropping the NOx emissions. It was found that 15% EGR rate is to be effective to reduce the NOx emissions without disturbing the performance of engine. [6]

Domenico De serio (2017) et. al. studied that the impacts of an EGR system on performance and emissions at a stationary direct injection, operating with diesel oil containing 7% biodiesel B7. Experiment carried out in a 49 KW diesel power with adapted EGR system and finally they concluded that the use of EGR was show to be feasible for reduction of NOx emissions from a diesel power generator with EGR B7[7].

Deepak Agrawal (2011) et.al. studied that EGR is a pre-treatment technique which is being used widely reduced and control the NOx emissions from diesel engine. Present experiment studied has been carried out of investigate the effect of EGR on soot deposits and wear off engine parts. Finally he concluded that higher carbon deposits. Where observed on the engine parts operating with EGR higher wear of piston rings with EGR. [8]

K Srivinvsa Rao (2015) et.al. studied that in C.I. engines, formation of NOx is increasing with biodiesel because of more amount of oxygen available. An experimental investigation was concluded to study the effect of EGR on diesel engine performance and emission characteristics fuelled with waste cooking oil, methyl ester and its with blends finally they concluded that the better engine where, obtained with EGR rate of 15% for all fuels blends. [9]

Kerimcan Celebi(2017) et. al. studied that due to high viscosity property of biodiesel injector life of an engine affected by viscosity fuels. BSFC increased with biodiesel where, as Hydrogen addition into intake manifolds improve the consumptions and finallyresults are the vibration acceleration of engine reduced with biodiesel and hydrogen addition. [10]

III. RESEARCH METHODOLOGY

A. Problem Statement

Recently the non-renewable energy sources are limited in stock. So, we have to go for alternative fuel as substitute. The vibration affects the performance as well as the comfort of operators, so it is necessary to evaluate the vibration characteristics of engine various operating parameters.

B. Aim Of The Project

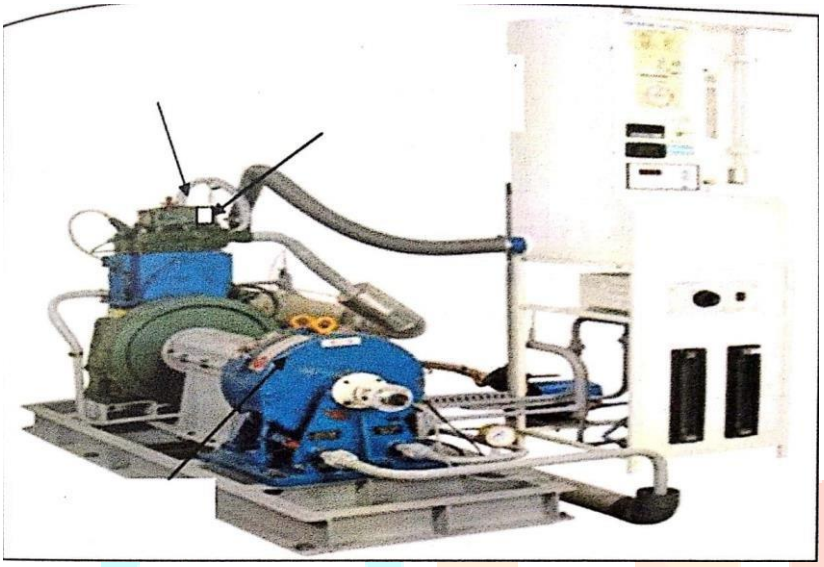
To study the effect of EGR on CI engine vibration as well as emission characteristics with various level of operating parameters.

C. Objective

1) To study the effect of input parameter i.e. Biodiesel percentage, EGR rate, Injection timing, Inlet temperature and pressure.
2) To study the Exhaust Gas Recirculation (EGR) rate.
3) To study the emissions.
4) To study the vibrations in X and Y directions.

IV. EXPERIMENTAL SETUP

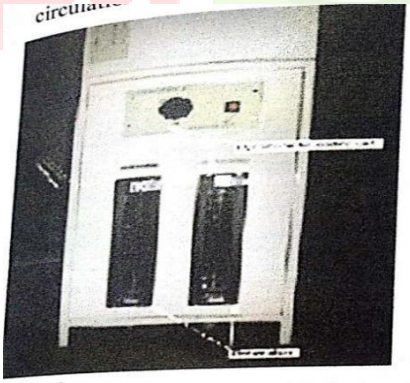
Schematic of experimental setup



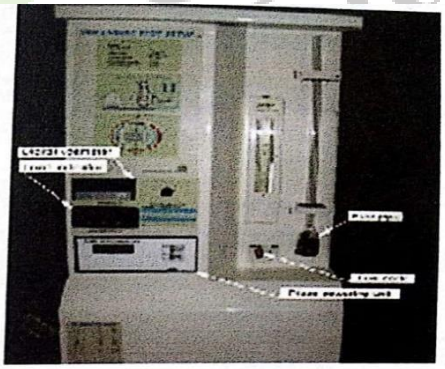
Above fig. Shows different component of experimental setup and how they are connected. It consists of following devices connectedto it as follows:

Test engine: Single cylinder four stroke water cooled diesel engine.

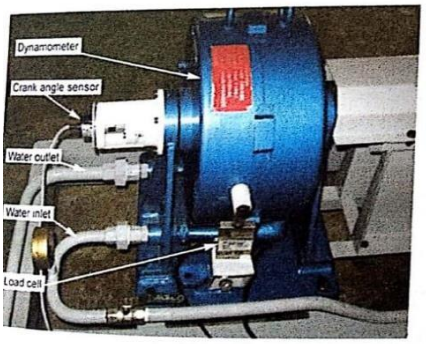
1) **EGR**: Manually Operated Cold EGR for experimentation.
2) **Dynamometer**: Eddy current dynamometer.
3) **Analyser**: Automotive emission analyser HG-540 This analyzer can analyze five combustion gases like Hydrocarbon (HC),Carbon monoxide(CO), Carbon dioxide(CO_2), Oxygen(O2).
4) **Temperature Controller/ Detector:** Thermometer.
5) **Computer:** For Software "IC engine combustion analyser software version. 9.0"



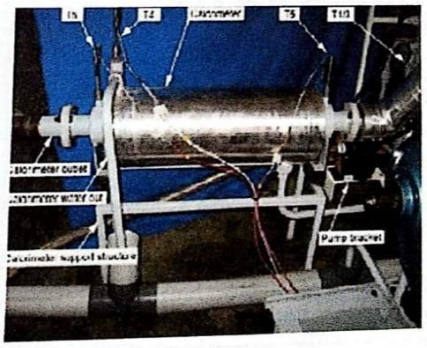
(a) Rotameter



(b) Load indicator uni



(c) Dynamometer



(d) Calorimeter

(Source: Appex Industries Lab Manual)

V. DESIGN OF EXPERIMENTATION

Table 1 : Level of Input Parameters

		LEVELS		
PARAMETERS	I	II	III	IV
%BLEND	10	20	30	40
CR	18	17	16	15
EGR	5%	10%	15%	20%
IT	23° bTDC	22° bTDC	21° bTDC	20° bTDC

Table No. 2 : Actual Design of Experiment

Run No.	**%Blend**	**CR**	**IP**	**EGR rate**
1	10	18	210	4
2	10	17	230	8
3	10	16	250	1
4	10	15	270	16
5	20	18	230	12
6	20	17	210	16
7	20	16	270	4
8	20	15	250	8
9	30	18	250	16
10	30	17	270	12
11	30	16	210	16
12	30	15	230	12
13	40	18	270	8
14	40	17	250	4
15	40	16	230	16
16	40	15	210	12

VI. OBSERVATION DATA AT FULL LOAD CONDITION:

The Result of diesel and biodiesel were compared and it is found that the result obtained with biodiesel are in the same range as that for diesel. The results of some operating parameters with biodiesel are shown in above table. For some tests the results are better for biodiesel.

Table No.3: Response variable data performance characteristics under full load condition

X acc m/s2	Y acc m/s2	BP KW	BMEP BAR	BTHE %	ITHE %	ήmech %	SFC Kg/kw-hr	ή vol
136.8	22.6	3.44	4.27	29.77	46.54	63.96	0.29	65.56
165	16.3	2.82	4.06	12.83	20.7	61.96	0.67	69.45
159.3	9.4	3.09	4.21	17.05	25.73	66.27	0.51	63.36
146.1	21.1	3.4	4.3	22.91	35.95	63.74	0.38	61.48
137.8	20.4	3.43	4.27	26.36	43.39	60.69	0.33	61.26
145.7	19.9	3.4	4.27	24	38.69	62.2	0.36	60.98
142.6	18.9	3.32	4.16	24.43	29.02	62.6	0.35	61.06
150.5	19.2	3.42	4.29	24.14	37.48	64.42	0.36	61.46
136.2	18.3	3.38	4.23	27.06	43.48	62.23	0.32	61.34
146.4	27.9	3.4	4.26	25.99	41.5	62.65	0.33	61.64
147.6	18.7	3.43	4.29	26.28	42.25	62.21	0.33	61.78
141.9	23.4	3.44	4.28	28.81	46.95	61.36	0.33	65.26
134.1	28.1	3.51	4.4	26.75	41.87	63.88	0.3	62.04
140.8	35.9	3.33	4.16	27.79	44.2	62.88	0.33	68.26
135.1	36.7	3.35	4.19	26.66	41.89	63.65	0.31	62.06
134.7	23.7	3.35	4.17	27.97	44.24	63.21	0.33	64.18

VI. CONCLUSION

According to this experiment we conclude that by using bio-diesel we can minimize the quantity of diesel required. In this experiment we performed the test for different EGR rates by using diesel-biodiesel blends. We observed the vibration amplitude depends upon load on engine. The vibration acceleration values more in linear direction as compared to lateral direction. The vibration is reduced to the optimum level and the NOx, CO emission level will get reduced. We will try to obtain the optimum level of input parameters i.e EGR rate, biodiesel percentage, injection timing, compression ratio to minimize the vibration of engine block to improve the comfort to human being. The experimentation shows that the fuel consumption rate, brake thermal efficiency. The exhaust temperature is increased while the BSFC, emission indices CO_2, CO decreased with an increased of engine speed. Also, in particular, biodiesel produced with the addition of the per oxidation process had the lowest equivalence ratio and emission indices of CO_2 CO. The thermal efficiency is found to have slightly increased with EGR at lower engine loads BSFC is lower at lower loads for engine operated with EGR from compared to without EGR. higher engine loads, BSFC with EGR is almost similar to that of without EGR. Exhaust gas temperature drops with increase in EGR rate. The reason of the temperature are less availability of oxygen and higher specific heats of recalculated and fresh air mixture. Also, this evaluates the performance and emission for different EGR rates of the engine. According to experimentation, the use of biodiesel tends to reduce the CO emission due to higher oxygen contents of biodiesel. The NO, emission increases while binary and tertiary blends are used due to higher cetane number, oxygen contents and injection timing of biodiesel. From experimentation we concluded that by changing the nozzle geometry the optimized level of vibration of engine block is achieved.

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