An experimental evaluation on CI engine – karanja oil with diesel blends as fuel subjected to EGR effect

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ABSTRACT

Bio-Diesel like Karanja were the renewable sources of power generation and propulsion. In our present experimental investigation karanja oil is mixed in the Diesel in different proportions such as 5 percentage, 10 percentage , 15 percentage and 20 percentage in the volume ratio and examined under similar conditions and compared with that of performance of Diesel. These combinations are tested under various proportion of exhaust gas re-circulation. In paper emission and performance are occured.

Key Words: *Diesel, karanja oil, EGR, Diesel Engine and emissions.*

INTRODUCTION:

The fossil fuels using inside the combustion engines which are non-renewable and are high impact on a country's economy. By doing Research we get to know that the oil is being drilled out from the earth that would exhaust within few years. This shows, the world is in the requirement of fuels that are renewable that can be indigenously produced in a country to save the economy. The bio fuels which were considered the best of the renewable fuels which can be produced by the indigenously. Bio-fuels are both gaseous fuels that can be called Bio gas and liquid fuels that which are termed as bio-diesels.

Exhaust Gas Re-circulation

Exhaust gas recirculation is technique to less the particulate residuals through resending a part of the exhaust gas into the inlet manifold, this also pre-heats the inletting air. EGR technique is used for reducing NOX and reduction of un-burnt gases.

In the present experimental investigation, the engine is run at various blends of kajanga oil in conjunction of diesel under EGR conditions at various load, compression ratio and injection pressure conditions to investigate and compare the performance and emissions at each condition and come out with the productive findings.

Karanja Oil

Millettia seeds which can be derived in the Karanja Oil or Pongamia oil.In asia the tropical temarature is native to the Pinnata tree.In south and Southeast Asia the Millettia pinnata is native .In different languages as Indian beech, Pongam, Karanja, Honge, Kanuga, and Naktamala, which is grown in overall the world. In fifth year the pods start yielding and the stabilizes in the 10th year Milletti pinnata is native to South and Southeast Asia. Known in different languages as Indian beech, Pongam, Honge, Kanuga ,Karanja, and Naktamala, it is now grown all over the world.The plant starts yielding pods from the 5th year on with the yields increasing each year until it stabilizes around the 10th year.

Pongamia oil is extracted from the seeds by expeller pressing, solvent extraction or cold pressing,. The oil which is in the yellowish-orange to brown in color. These will be toxic and will reduce the nausea and vomiting if eaten, but it is used in many traditional remedies. It has a high content of triglycerides, and its disagreeable taste and odor are due to bitter flavonoid constituents including pongamol, tannin , and karanja chromene.

The physical properties of the Karanja oil are as given below.

Property	Methyl esters	ASTM D6751	EN 14214
Acid value(mg KOH/g)	0.46 - 0.5	<0.8	<0.5
Calorific value(kcal/kg)	3700		
Cetane Number	41.7 – 56	>45	>51
Density at 15°C (g/cm3)	0.86 - 0.88	0.87 - 0.89	0.86 - 0.90
Viscosity at 40°C(mm2/s)	4.77	1.9 - 6.0	3.5 - 5.0
Boiling point (°C)	316		
Cloud point(°C)	19		0/-15
Fire Point(°C)	230		
Flash point(°C)	174	>130	>101

Table 1: Properties of Karanja Oil

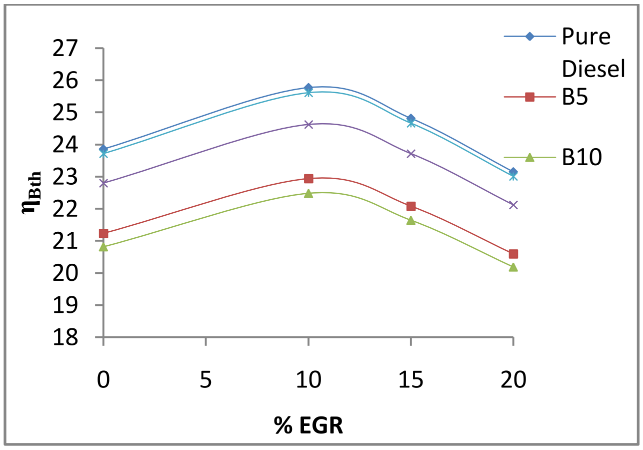
A researcher which has been conducted by an experimental investigation of performance and emission of karanja oil and its is blended (10percentage ,20percentage,50percentage and 75percentage) visa-visa mineral diesel in a single cylinder agricultural diesel engine. In this study physical and thermal properties of karanja oil were evaluated. Author conducted two set of experiment, one set for unheated and second for preheated fuel samples. Without preheating set of experimentation shows higher brake thermal efficiency except B100 and BSFC up to 50% was lower than diesel .pre-heating set of experimentation shows higher brake thermal efficiency and lower BSFC for all blends as compared with diesel fuel. BSFC for unheated and heated karanja oil were lower and exhaust gas temperature was generally higher than diesel for all blends. NOx emission was found to be less as compared with diesel for both set oil.

Another researcher in this paper he studied about the development of biodiesel from karanja tree, mainly found in rural India has been investigated. The biodiesel was developed from oil expelled from the seeds of the tree. Molecular weight of the oil was determined and found to be 892.7. Both the acid as well as alkaline esterification was subsequently performed to get the final product. NaOH was found to be a better catalyst than KOH in terms of yield.Maximum yield of 89.5% was achieved at 8:1 molar ratio for acid esterification and 9:1 molar ratio for alkaline esterification, 0.5 wt. % catalyst (NaOH/KOH) using mechanical stirrer.Sudipta Choudhury et al 2007 [9] in this paper he presents the suitability of Pongamia Pinnata (karanja) as a source of renewable fuel substituting petro diesel in CI engine.Physical and chemical properties of karanja oil suggest that it cannot be used directly as CI engine fuel due to higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber. Based on engine emissionstudies i.e. CO, NOX and hydrocarbon, we can say that all the parameters are within maximum limits that conclude safer use as an alternate fuel. The straight karanja oil blend up to 25% with the petro diesel meets the standard specification. However blending of this oil with petro diesel up to 20% (by volume) can be used safely in a conventional CI engine without any engine modification that could help in controlling air pollution.

Results and Discussions:

Significant results were drawn out of the obtained readings and compared as below.

Brake thermal efficiency:

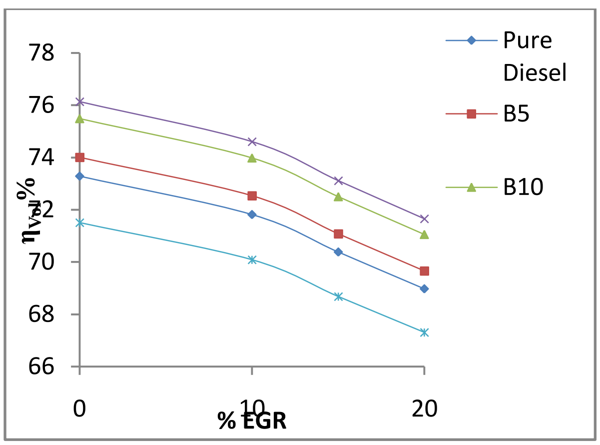


Graph 1: Break thermal efficiency Vs EGR% at various Karanja Substitutions in Diesel.

As shown in graph 1 the Brake thermal efficiency at each blend is increased by 20% with 10% induction of EGR when compared to that of pure diesel, the left over particles in the exhaust gas acts as the additional fuel causing the raise in the efficiency. Further, the increase in the EGR induction by 15% the efficiency is only 8% more than that of the pure diesel, this is due to increased proportion of the exhaust gas in the incoming charge decreases the oxygen content in the combustion chamber. The same valid for the explanation of the brake thermal efficiency decreasing by 18% compared to pure diesel at 20% EGR induction

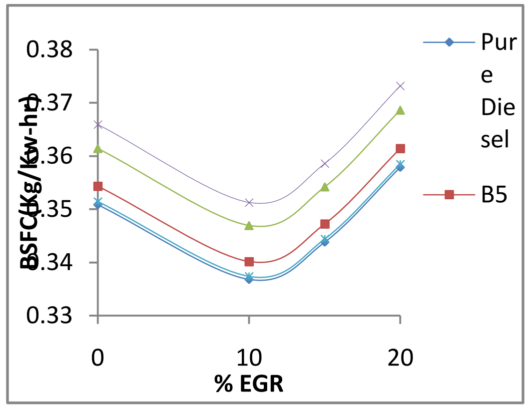
Volumetric efficiency:

The volumetric efficiency is the breathing capacity of the engine, good volumetric efficiency indicates healthy engine. The Graph 2 shows the volumetric efficiency at various blends, theoretically he liquid fuels have a little effect on the volumetric efficiency. The induction of the EGR reduce the space for the inlet charge and volumetric efficiency, this explains the decrease of the volumetric efficiency by 8%, 16% and 23% of volumetric efficiency at the EGR substitution of 10%, 15% and 20% respectively.



Graph 2: Volumetric efficiency Vs EGR % at various Blends

Break Specific Fuel Consumption:



Graph 3: BSFC Vs EGR% at various Blends

Brake Specific fuel consumption is another important parameter that determines the performance of any engine. It is the specific quantity of fuel used to generate a unit of power. The BSFC at each blend is decreased by 20% with 10% induction of EGR when compared to that of pure diesel, the left over particles in the exhaust gas acts as the additional fuel causing the decrease in the BSFC. Further, the increase in the EGR induction by 15% the BSFC is only 8% less than that of the pure diesel, this is due to increased proportion of the exhaust gas in the incoming charge decreases the oxygen content in the combustion chamber. The same valid for the explanation of the BSFC increasing by 18% compared to pure diesel at 20% EGR induction.

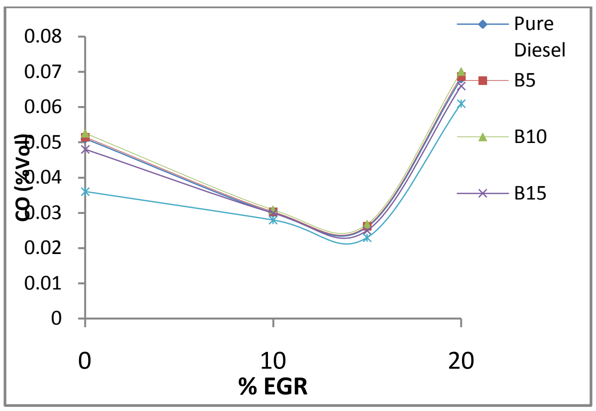
Emissions:

After validation of performance parameters emissions stand to determine the suitability f a running condition of an Engine. Below given are the emissions that are measured and compared at the focussed running conditions.

Oxides of Carbon(CO and CO_2):

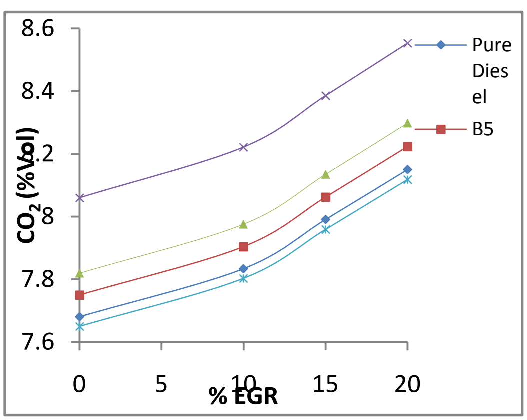
Carbon Monoxide(CO):

Carbon monoxide is an oxide of carbon that is partially oxidized during the combustion process and has adverse effect on the environment and human health. The Graph 4 presenting the variation of CO in percentage Volume at varying EGR substitution at all the blends. The decrease of the CO is for the 10% and 15% is noted as per the Graph 4, the un-oxidized oxides of carbon gets second chance to get oxidized when re-circulated in combustion chamber. This explains the decreasing trends in the graph.



Graph 4: CO (% Volume) Vs EGR% at various Blends

Carbon-Dioxide(CO2):

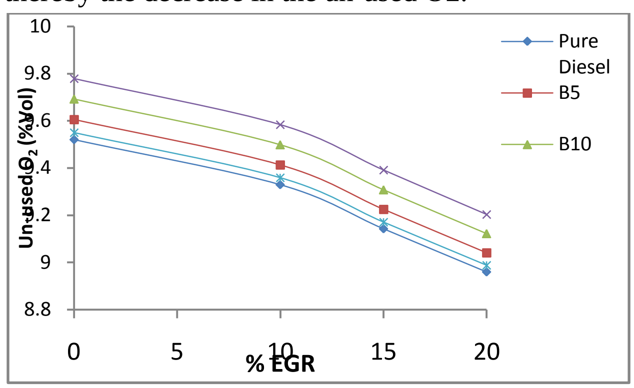


Graph 5: CO2 (% Volume) Vs EGR% at various Blends

Carbon Dioxide is another oxide of carbon that is the complete oxidized form of carbon in the combustion chamber. Emissions of CO2 also need to be considered serious as it is one of green house gas. Graph 5 shows the picture of CO2 Variation with or the various blends.

Un-used Oxygen:

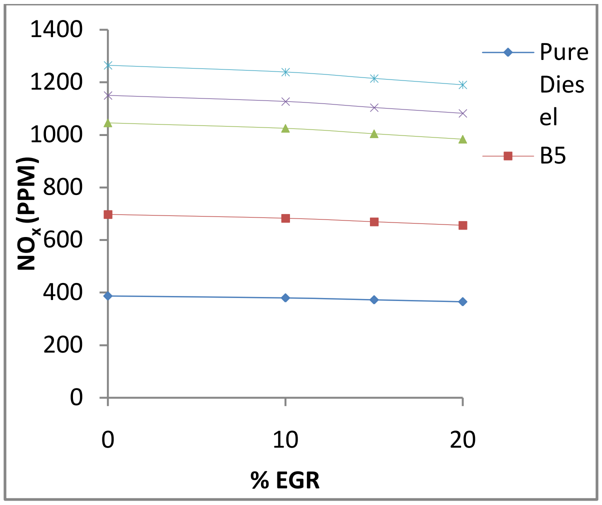
The un-used or the un-reacted oxygen is percentage of oxygen inside the exhaust gas, more usage of oxygen implies better combustion and thereby better performance, less amount of un-used oxygen is desired as it indicates the better combustion. The Graphs 6 of the un-used O2 with decreasing EGR substitution. As the EGR substitution increases the space for oxygen inside the combustion chamber decreases, thereby the decrease in the un-used O2.



Graph 6: Un-used Oxygen (% Volume) Vs EGR% at various Blends

Oxides of Nitrogen (NOx):

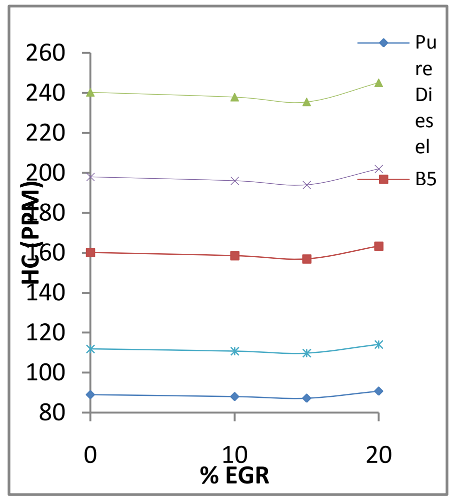
Oxides of Nitrogen are the automotive emissions that need to be adversely considered in engine life and environmental stand point. The Graph 7 presents the decreasing NOx with increasing EGR substitution at all blends. As the EGR substitution increases the space for oxygen inside the combustion chamber, thereby the decrease in the oxidation of the Nitrogen compounds and resulting in the decrease in the NOX Emissions with the increase in the CNG substitution.



Graph 7: NOx (PPM) Vs EGR% at various Blends

Un-burnt hydro Carbons(HC):

The fuels used in the engine are hydro carbon fuels, the fully burnt or reacted hydro carbons generate power where as the un-burnt hydro carbons come out of tail pipe as harmful emissions. The graph 8 projects the increase in hydrocarbons with the increase in the EGR substitution. The EGR composition inside the combustion chamber causes increase in the hydrocarbon content that is being the reason for the decreasing trend in the graphs.



Graph 8: HC (PPM) Vs EGR% at various Blends

Conclusions:

The data inferred from the results and discussions suggest that the induction of the EGR is showing a positive impact on the performance of the engine till 10% and 15%. The deterioration is noted at 20% EGR. The same trend is seen in emission for the ER where the emission improved till 15% and deteriorated above it.

Nomenclature:

Notation	**Term**	**Units**
η_{Bth}	Break thermal efficiency	%
η_{Vol}	Volumetric efficiency	%
BSFC	Break specific fuel consumption	Kg/KW-Hr
CO	Carbon Mono Oxide	% volume
CO2	carbon Di-Oxide	% volume
EGR	Exhaust Gas Re-circulation	% volume
NOX	Oxides of Nitrogen	PPM
HC	un-burnt Hyrdro carbons	PPM

Table 4: Nomenclature

Notation	Constituents	
	Diesel%	Karanja%
B5	95	5
B10	90	10
B15	85	15
B20	80	20

Table 5: Explanation of blends

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