EXPERIMENTAL STUDY OF PERFORMANCE AND EMISSION OF AN CI ENGINE FUELLED BY BLENDS OF LEMON OIL WITH BIODIESEL

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Abstract: A single cylinder four stroke variable compression multi fuel engine is used to study the performance and exhaust emission when fueled with 5%, 10% and 20% of lemon oil and methanol blended with diesel are investigated and compared with standard diesel. Experiments were carried out at different loading conditions. The effect of using different blend percentages on brake thermal efficiency, brake specific fuel consumption and exhaust emissions has been investigated and presented in this paper.

Keywords:- Brake thermal efficiency, emissions, spark angle, Lemon Peel oil, Brake specific fuel consumption.

I. Introduction

Exhaust emission produced by vehicles is the major concern for raise in pollution in most metropolitan cities. Due to rapid modernization and increasing population the number of vehicles has been increased causing rapid increasing the pollution. Bio fuels are looking as an important prospect to look in to thereby reducing the fuel consumption. Bio fuels sacrifice either performance for better emission or for better performance high emissions. Basavaraj M. Shirgiri et al. studied the performance, emission, and combustion characteristics of low heat rejection diesel engine using cotton seed and neem kernel oil methyl esters and compared both of them. They observed that there is a decrease in brake thermal efficiency by 5.91%, and 7.07% and brake specific fuel consumption is increased by 28.57% and 10.71%. They found that there is an increase in exhaust emission in which NOx has higher increase there is slight increase in carbon monoxide, smoke and hydrocarbon. K.Sivaramakrishnan investigated the performance and emission characteristics of a variable compression engine fueled with karanja and diesel blend. He conducted experiments with 20%, 25% and 30% blend s of the fuel at different compression ratios of 15:1, 16:1, 17:1 and 18:1. 25% karanja biodiesel-diesel blend produced the best results for a compression ratio of 18:1. He observed that there is an increase in brake thermal efficiency with increase in compression ratio, 30.46% is the maximum brake thermal efficiency. The minimum hydrocarbon emissions were obtained at 20% blend and Co emissions were minimum at 25% blend. Senthil Ramalingam et al. studied the performance, emission and combustion characteristics of diesel engine operated using Annona methyl ester by different injection timing and compression ratio. They found out that 20% blend can be used without any modifications to the engine. Optimum compression ratio and injection timing for better performance is 19.5 and 30^0 BTDC respectively. They observed that there is increase in brake thermal efficiency, reduction in specific fuel consumption and decrease in exhaust emissions with both increase in compression ratio and injection timing. S V Channapattana et al. investigated emission and performance using direct injection CI engine using honne oil methyl ester as bio diesel at different compression ratio 15:1, 16:1, 17:1 and 18:1. The engine operated at different fuel blends B20- B100 blend. B20 blend give better performance close to diesel for 18:1 compression ratio with 100% bio diesel there is 8.9% decrease in brake thermal efficiency and increase in specific fuel consumption. There is an increase in NOx emission at higher compression ratio and decrease in carbon monoxide and hydro carbon emission and increase in carbon dioxide emission. T. Balusamy et al. studied the effect of injection pressure and injection time on compression ignition engine fueled with methyl ester of thevetia peruviana seed oil and found out that optimum injection pressure and injection timing as 225 bar and 27^0 before TDC respectively. They observed that there is a significant increase in brake thermal efficiency and reduction in brake specific fuel consumption, carbon monoxide, hydro carbons and smoke emission by advancing the injection pressure. G.R.K. Sastry et al conducted experiments using fish oil bio diesel blends on diesel engine to analyze the vibration emission and performance. Fish oil in different percentages i.e. 20%, 30%, 40% is used to conduct the experiments they observed that there is increase in brake specific fuel consumption and reduction in brake thermal efficiency, carbon monoxide and smoke, increase in NOx emission.

G. Venkata subbaiah et al. investigated experimentally the performance and emission characteristics of a direct injection diesel engine fueled with rice bran bio diesel and ethanol blends. They conducted experiments using three different blend percentages and observed that 2.5% ethanol blended biodiesel produced optimum results.

There is 27.47% reduction smoke emission and reduction in carbon monoxide, unused oxygen, hydro carbons with 2.5% ethanol blend. Jayadhri N. Nair et al. analyzed the performance and exhaust emission on compression ignition engine using neem biodiesel as fuel. The experiments were carried out at 10%, 20% 30% bio diesel blends and the optimum performance and exhaust emissions were obtained at 10% blend percentage. They observed that 23% ,8.5% and 22% reduction in carbon monoxide, hydro carbons and NOx emission respectively and increase in brake thermal efficiency and reduction in brake specific fuel consumption when compared with diesel. S. Nagaraja et al. conducted experiments using preheated palm oil- diesel blends at different compression ratio to examine the performance and emission characteristics. The experiments were carried out at 5%, 10%, 15% and 20% blend percentages over five compression ratios i.e. 16:1 to 20:1. The optimum performance conditions were observed at 20% blend percentage at 20:1 compression ratio. They observed there is an increase in carbon dioxide and decrease in carbon monoxide and hydrocarbon emissions and there is 6% increase in brake power.

II EXPERIMENTAL SETUP

A single cylinder four stroke engine, multi fuel with variable compression ratio and injection angle was used to carry out the experiments. The engine was equipped with eddy current dynamometer for loading purpose. The setup consists of two fuel tanks for both diesel and gasoline. port fuel injection system was used as fuel injection system. Exhaust gases were analyzed by AVL gas analyzer. The pressure sensor was attached to the engine head to measure the combustion pressure in the engine cylinder. Several data acquisition systems are connected to the experimental setup to process the data obtained. Different parameters (i.e. volumetric efficiency, brake thermal efficiency, brake power etc.) can be studied using this setup.

Table 1: Engine specifications

Engine Type	Single cylinder, 4-stroke CI engine
Cylinder bore	87 (mm)
Stroke length	110 (mm)
Connecting rod length	234 (mm)
Compression ratio	16:1
Swept volume	661 (cc)
Rated power	4.50 kw @1800 rpm
Throttle orifice diameter	20 (mm)
Orifice Coefficient of discharge	0.6
Dynamometer arm length	185 (mm)
Fuel Pipe Diameter	12 (mm)

III TEST FUEL

Orange oil and ethanol are blended with diesel to study the performance characteristics. Orange oil and ethanol oil are blended in 2:1 ratio (i.e. for 10% bio diesel blend it consist of 7.5% orange oil and 2.5% ethanol). Bio diesel blend of 10%, 20%, and 30% are used to conduct this experiment. Properties of both orange oil and ethanol are mentioned below in the table: 2

Table 2: Fuel properties

Density @ 30 ^{0}C (kg/m3)	0.8169
Kinematic viscosity @ 40^0 C (cSt)	3.52
Flash point (^{0}C)	74
Fire point (^{0}C)	82
Lower calorific value (kJ/kg)	34,650
Cetane number	47

IV RESULTS AND DISCUSSION

Carbon monoxide:

Variation of carbon monoxide with change in brake mean effective pressure at different blend percentages has been shown in figure 1. It has been observed that with increase in blend percentage there is a increase in carbon monoxide percentage at each brake mean effective pressure. But there is decrease in carbon monoxide percentage when each blend is compared with different brake mean effective pressure.

Break Mean Effective Pressure (bar)	Carbon monoxide (%)		
	LPO 0%	LPO 5%	LPO 10%
1.14	1.02	1.25	1.41
2.34	1.08	0.9625	0.892
3.75	0.38	0.3175	0.233

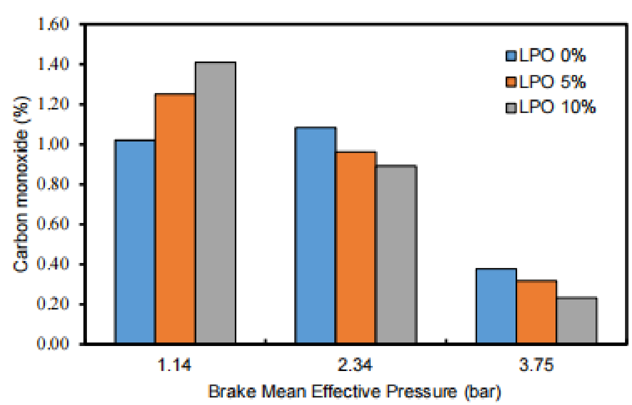


Figure 1: Variation of CO emission with different load conditions

Hydro carbons:

Variation of Hydro carbon with change in brake mean effective pressure at different blend percentages has been shown in figure 2. It has been observed that with increase in blend percentage there is increase in Hydro carbon percentage at each brake mean effective pressure. But there is decrease in Hydro carbon percentage when each blend is compared with different brake mean Smoke Emission:

Variation of carbon monoxide with change in brake mean effective pressure at different blend percentages have been shown in figure 4. It has been observed that bio diesel blends produce more smoke emission than diesel. There is a decrease in smoke emission with increase in brake mean effective pressure at each blend percentages but there is increase in smoke emission with increase in blend percentage at each brake mean effective pressure.

Break Mean Effective Pressure (bar)	Brake Specific Fuel Consumption (Kg/Kwh)		
	LPO 0%	LPO 5%	LPO 10%
1.14	0.433	0.48	0.529
2.34	0.335	0.341	0.402
3.75	0.272	0.29226	0.317

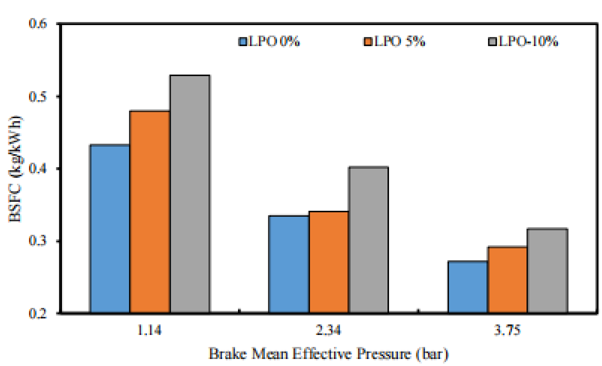


Figure 2: Variation of BSFC with Break mean effective pressure.

Break Mean Effective Pressure (bar)	Hydrocarbons (ppm)		
	LPO 0%	LPO 5%	LPO 10%
1.14	363.44	215.18	369.82
2.34	137.5	166.5	186.4
3.75	119.77	145.19	204.24

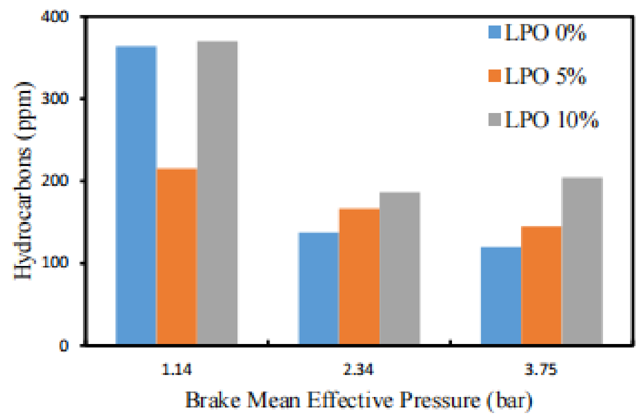


Figure 3: Variation of Hydrocarbons with brake mean effective pressure

NOx Emission:

Variation of carbon monoxide with change in brake mean effective pressure at different blend percentages have been shown in figure 3. It has been observed that with increase in blend percentage there is increase in NOx emission percentage at each brake mean effectivpressure. But there is decrease in NOX emission percentage when each blend is compared with different brake mean effective pressure.

Break Mean Effective Pressure (bar)	Brake Thermal Efficiency (%)		
	LPO 0%	LPO 5%	LPO 10%
1.14	18.87	17.11	15.5
2.34	24.93	24.06	20.45
3.75	30.02	28.088	25.88

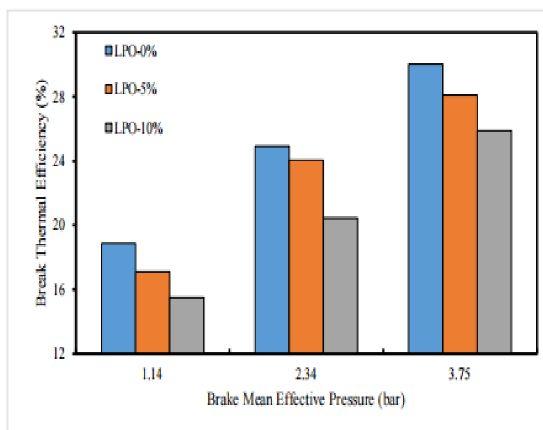
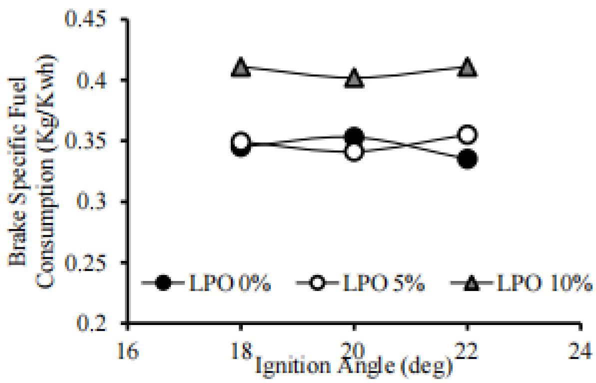


Figure 4:Variation of Brake Thermal Efficiency with Break mean effective pressure.

Brake Specific Fuel Consumption:

Brake specific fuel consumption is the ratio of brake power to the mass of fuel consumed. It is the vice versa of brake thermal efficiency. It is observed that with an increase in blend percentage there is an increase in fuel consumption due to its less calorific value. For LPO 0% brake specific fuel consumption is minimum at 22^0 BTDC ignition angle. But for LPO 5% and LPO 10% the minimum brake specific fuel consumption was obtained at 20^0 BTDC ignition angle.



V CONCLUSION

Orange oil and ethanol are used as bio diesel and its additive the emission characteristics at different brake mean effective pressures has been studied in this experiment. It has been observed that B30 blend produced low emission characteristics. Except NOx all the emissions decreased with increase in brake mean effective pressure but increased with increase in blend percentage at each brake mean effective pressure. NOx emission increased with increase in blend percentage and brake mean effective pressure.

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