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Performance and Emission Characteristics of a V.C.R C.I Engine using Chicken Waste Based Bio-Diesel with Blended Fuels

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ABSTRACT
This project deals with the preparation of Oil (extraction of oil) from the chicken waste which is obtained from tri-glycerides through the transesterification process to find Performance and emission characteristics of V.C.R diesel engine with ratio 18:1 fuelled with rendered chicken oil with five different blends at speed 1500rpm. The chicken oil is prepared from waste chicken available at poultry form. The blends are made as B0, B5, B10, B15, B20, & B25. The performance characteristics like specific fuel Consumption, brake power, indicated power, brake thermal efficiency, indicated thermal efficiency and mechanical efficiency are evaluated and made comparison. This report explains the emission characteristics of all blended bio-fuels at different loads

Keywords: *Rendered chicken oil, V.C.R. C.I engine, Performance, Emissions.*

1. INTRODUCTION
Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petro-diesel in combustion properties. Increasing environmental concern, diminishing petroleum reserves and agriculture based countries are the driving forces to promote biodiesel as an alternate fuel. Vegetable oils and animal fat oils being renewable, non-toxic, biodegradable with low emission profiles are suitable alternative fuels to diesel. Biodiesel derived from vegetable oil and animal fats is being used to reduce air pollution and to reduce dependence on fossil fuel. Biodiesel can be harvested and sourced from chicken waste. Higher viscosity, lower volatility and polyunsaturated character of animal fat oils pose normal engine operational problems. Transesterification is the method of optimizing the characteristics of animal fat oils.

This thesis about conversion of oil from chicken waste in to biodiesel and performance test conducted on stationary single cylinder diesel engine by using chicken waste extracted oil blends with diesel fuel for no load to full load condition. These tests were also conducted with conventional diesel fuel for comparison.

2. PREPARATION AND PROPERTIES:

PRODUCTION OF BIO DIESEL: The chicken that is taken into a vessel boiled along with water and temperature maintained above 100 degree centigrade. After water evaporation the stock is squeezed to extract oil. The animal fat oil (chicken waste oil) is filtered to remove dirt, charred food, and other non-oil material often found in the oil. The catalyst is typically sodium hydroxide (caustic soda) or calcium oxide (lime). It is dissolved in the alcohol using a standard agitator or mixer. The alcohol/catalyst mix is then charged into a vessel and the oil is added. The system from here on is totally closed to the atmosphere to prevent the loss of alcohol. The reaction mix is kept just above the boiling point of the alcohol (around 160 °F) to speed up the reaction.

The triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkali like sulfuric acid. The main reason for doing a titration to produce biodiesel, is to find out how much alkaline is needed to completely neutralize any free fatty acids present, thus ensuring a complete transesterification. Once the reaction is complete, two major products exist: glycerin and biodiesel. Each has a substantial amount of the excess methanol that was used in the reaction. The glycerin phase is much denser than biodiesel phase and the two can be gravity separated with glycerin simply drawn off the bottom of the settling vessel. Once the glycerin and biodiesel phases separated, the excess alcohol in each phase is removed with a flash evaporation process or by distillation. In others systems, the alcohol is removed and the mixture neutralized before the glycerin and esters have been separated

EXPERIMENTATION:

Computerized VCR Engine and Gas Fuel Gas Analyzer

Economical speed test is conducted by keeping the load on the engine constant at various speeds: fuel consumed by engine is determined. Economical speed of engine is defined as speed at which the minimum fuel consumption takes place at a given load.

Table.1.PROPERTIES OF RENDERED CHICKEN OIL:

S. No	Characteristics	Unit	Test Method	Rendered Chicken Oil
1	Density	gm/cc	ASTM D1448	0.87
2	Calorific value	MJ/kg	ASTM D6751	39.34
3	Viscosity	centistokes	ASTMD445	5.4
4	Flash point	˚c	ASTMD93	174
5	Pour point	˚c	ASTMD2500	12.3
6	Cloud point	˚c	ASTMD2500	14

EDDY CURRENT DYNAMOMETER:

It consists of stator on which are fitted a number of electro magnets and a rotor disc made of copper or steel and coupled to output shaft of engine. A circular field coil in the stator provides the magnetic flux. The rotor is connected to the engine shaft and the rotor rotates eddy currents produced in the rotor due to magnetic flux set up by passage of field current in the electro magnets. This eddy current opposed to rotor motion, thus loading engine. The engine chosen for testing the performance of bio-diesel is single cylinder, four stroke, water cooled, compression ignition, single cylinder diesel engine test rig.

Fig.1. computerized VCR engine and gas fuel gas analyzer

Table.2.Specifications of the VCR engine used:

Type	Kirloskar, single cylinder, inline, vertical, water cooling
No. of strokes	Four
Rated Power	3.7 kW
Bore/Stroke	80mm/110mm
Rated RPM	1500
Compression ratio	7:1 to 20:1
Injection timing	23 º before top dead center
Type of ignition	Compression ignition
Method of loading	Eddy current dynamometer
Method of starting	Manual crank start
Injection opening pressure	200 bar (std.)

Table.3. Performance test parameters of Diesel:

S. NO	Load (w) (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	74.74	0.4	0	1.4	--	0	1.9861	0	27.7655	0
2	2	67.66	0.4402	0.4368	1.836	1.0077	0.632	2.6229	7.872	33.1016	23.78
3	4	67.37	0.5192	0.8733	2.273	0.5947	1.2636	3.2699	13.34	34.7343	38.41
4	6	61	0.5841	1.3343	2.734	0.4377	1.9307	3.9565	18.12	37.1361	48.79
5	8	45.56	0.6538	1.7952	3.195	0.3641	2.5976	4.6545	21.78	38.7695	56.28
6	10	40.75	0.731	2.2319	3.631	0.3275	3.2295	5.3264	24.22	39.4143	61.25

Table.4.Performance test parameters of B05:

S. NO	Load w1 (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	85.57	0.3503	0	1.6	--	0	2.2609	0	38	0
2	2	72.69	0.4124	0.467	2.0672	0.8827	0.6671	2.9519	9.574	42.361	22.6
3	4	62.44	0.4801	0.93	2.5308	0.5157	1.3344	3.6282	16.384	44.548	36.78
4	6	53.6	0.5593	1.402	3.0028	0.3987	2.019	4.322	21.196	45.372	46.72
5	8	47.66	0.629	1.856	3.4562	0.3388	2.7039	5.0347	24.939	46.463	53.71
6	10	42.38	0.7073	2.292	3.8924	0.3085	3.371	5.7239	27.39	46.507	58.89

Table.5.Performance test parameters of B10:

S. NO	Load w1 (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	91.65	0.329	0	1.4	--	0	1.9305	0	34.5379	0
2	2	73.22	0.409	0.4709	1.8709	0.8685	0.6671	2.6506	9.344	37.127	31.57
3	4	62	0.4865	0.9314	2.3314	0.5222	1.3343	3.3401	15.542	38.9304	43.16
4	6	54.97	0.5486	1.3954	2.7925	0.3931	2.0191	4.045	20.645	41.357	59.36
5	8	48.41	0.6229	1.861	3.261	0.3347	2.7036	4.7376	23.979	42.491	67.25
6	10	42.16	0.7153	2.283	3.683	0.3133	3.3709	5.4381	25.905	41.79	71.98

Table.6.Performance test parameters of B15:

S. NO	Load w1 (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	81	0.3745	0	1.5	--	0	2.0711	0	32.8892	0
2	2	69.5	0.4364	0.4721	1.972	0.9243	0.6671	2.7867	8.8831	37.1072	23.93
3	4	59.69	0.5082	0.9308	2.4308	0.5499	1.3344	3.4848	15.04	39.276	38.29
4	6	52.78	0.5747	1.3972	2.8972	0.4113	2.019	3.5127	19.963	41.395	48.22
5	8	45.97	0.6529	1.8562	3.3562	0.3517	2.7039	4.2204	23.345	42.21	55.3
6	10	41.04	0.7399	2.2769	3.7769	0.3249	3.3711	5.592	25.269	41.9157	60.27

Table.7.Performance test parameters of B20:

S. NO	Load w1 (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	84.44	0.3613	0	1.6	--	0	2.2668	0	36.7939	0
2	2	71.03	0.4296	0.4684	2.068	0.9171	0.6671	2.9458	9.0589	40.0031	22.64
3	4	59.5	0.5128	0.9295	2.5295	0.5516	1.3343	3.6311	15.06	40.98	36.74
4	6	52.28	0.5836	1.3972	2.9972	0.4176	2.019	4.3312	19.891	42.6701	46.16
5	8	45.54	0.67	1.8537	3.4537	0.3614	2.7039	5.0378	22.987	42.8285	53.67
6	10	41.1	0.7429	2.2862	3.886	0.3247	3.371	5.7303	25.586	43.4921	58.83

Table.8.Performance test parameters of B25:

S. NO	Load w1 (kg)	Time taken to 10cc fuel consumption (sec)	FCH (kg/hr)	BP (kw)	IP (kw)	SFC (kg/kw-hr)	Bmep (Bar)	Imep (Bar)	η bth %	η ith %	η mech %
1	0	86.41	0.3552	0	1.65	--	0	2.3135	0	39.1678	0
2	2	70.1	0.4378	0.4684	2.4964	0.9346	0.6671	3.5554	8.9957	47.94	25.97
3	4	59.34	0.5172	0.9286	2.5783	0.551	1.3343	3.7061	15.091	41.914	36
4	6	52	0.5902	1.3768	3.0268	0.4284	2.0191	4.439	19.614	43.1197	45.48
5	8	45.5	0.6766	1.8313	3.4813	0.3194	2.7039	5.1403	22.757	43.2616	52.6
6	10	40.47	0.7584	2.2676	3.9176	0.3344	3.3711	5.8241	25.14	43.43	57.88

Table.8.Emission test parameters of Diesel:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.05	16	1	4
2	0.056	19	1.6	11
3	0.065	23	2.2	12
4	0.076	24	2.8	13
5	0.082	25	3.1	14
6	0.095	27	3.7	16

Table.8. Emission test parameters of B5:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.042	5	0.64	0
2	0.0425	11	0.72	1
3	0.043	13	0.98	3
4	0.0436	16	1.5	7
5	0.0513	20	1.6	9
6	0.055	22	2.1	10

Table.8. Emission test parameters of B10:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.041	4	0.62	0
2	0.0412	10	0.69	2
3	0.0425	15	0.9	4
4	0.0436	16	1.2	6
5	0.06	17	1.4	8
6	0.065	19	2	9

Table.8. Emission test parameters of B15:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.044	3	0.6	1
2	0.045	9	0.66	3
3	0.0465	12	0.92	5
4	0.0476	15	1.21	6
5	0.062	18	1.46	7
6	0.07	20	2.2	10

Table.8. Emission test parameters of B20:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.045	8	0.64	3
2	0.0462	12	0.68	5
3	0.0485	14	0.92	6
4	0.052	15	1.19	8
5	0.062	19	1.45	10
6	0.065	21	2.2	12

Table.8. Emission test parameters of B25:

S.No	EXHAUST GAS ANALYSIS			
	CO %vol	HC ppm	CO2 %vol	NOX %vol
1	0.041	4	0.78	4
2	0.0412	10	0.89	5
3	0.0425	15	1.25	8
4	0.0436	6	1.8	10
5	0.06	17	2.2	14
6	0.065	19	2.6	16

3. RESULT AND DISCUSSION

Performance curves for diesel and different blends of bio-diesel

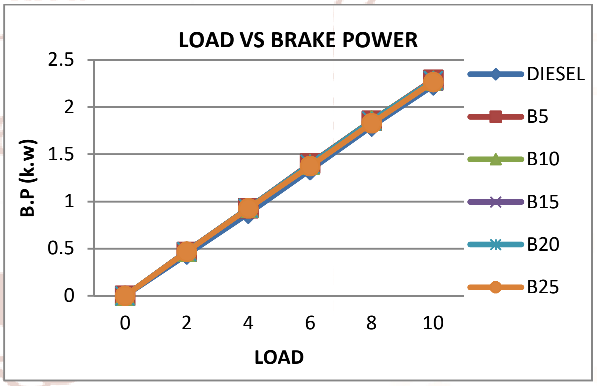

Fig.3. Comparison of Brake power at different loads

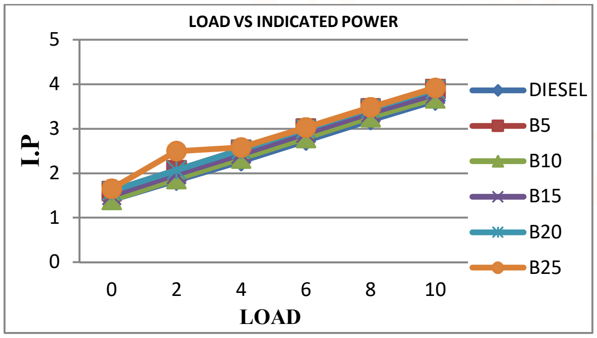

Fig.4. Comparison of indicated power at different loads

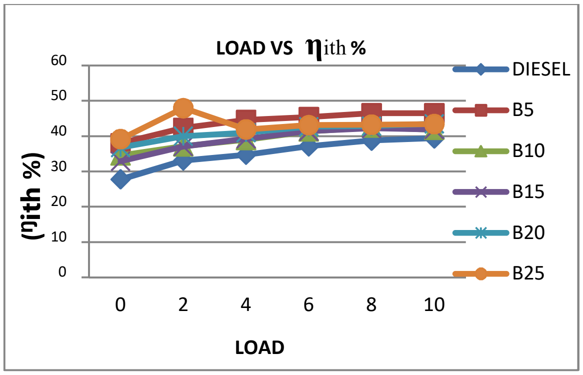

Fig.5. Comparison of Indicated thermal efficiency at different loads

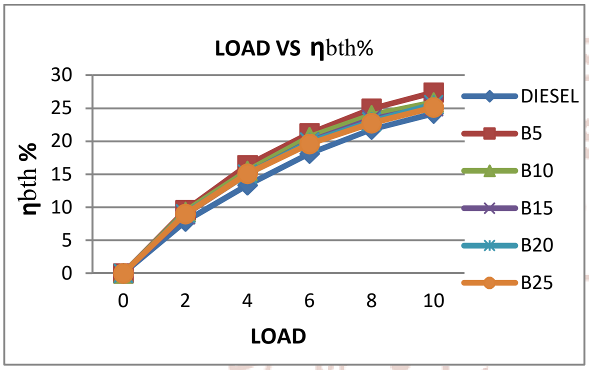

Fig.6. Comparison of Brake thermal efficiency at different loads

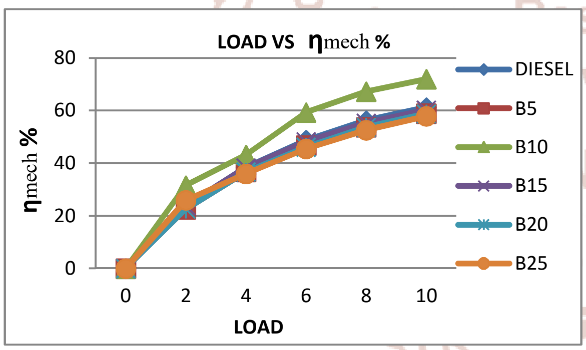

Fig.7.Comparison of mechanical efficiency at different loads

EMISSION TEST RESULTS

Percentage of pollutants at different loads

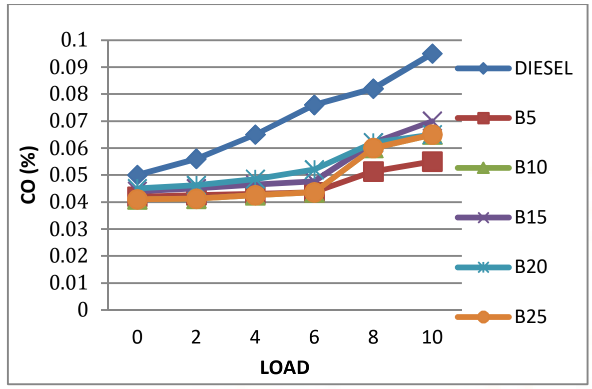

Fig.8. Percentage of CO at different loads

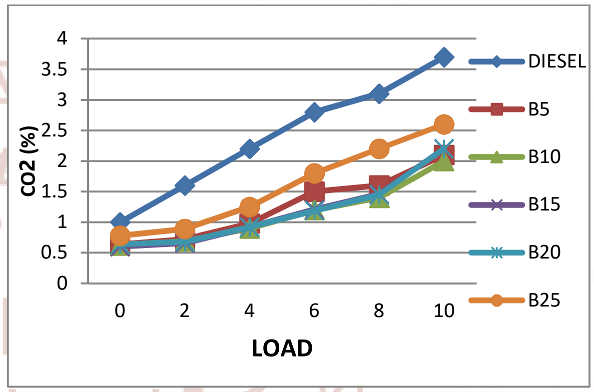

Fig.9. Percentage of CO2 at different loads

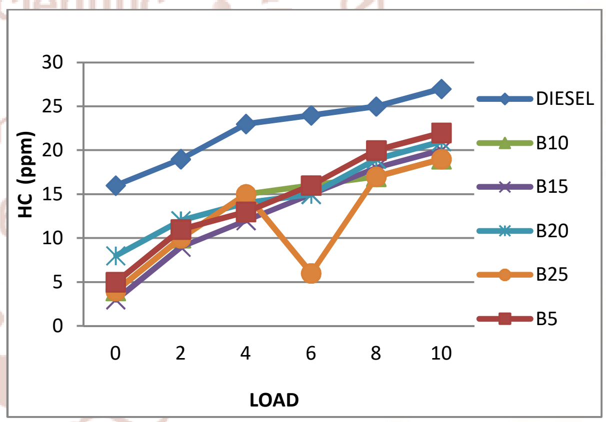

Fig.10. Hydro carbons (HC) in ppm at different loads

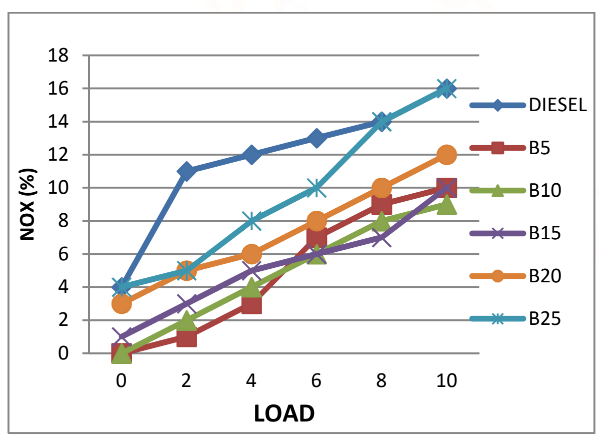

Fig.11. Percentage of NOX at different loads

4. CONCLUSION:

A single cylinder high speed diesel engine was operated successfully using CWBD and its blends with diesel. The following conclusion are made based on experimental results.

- Engine works smoothly on CWBD with performance comparable to diesel operation
- CWBD result is increased in brake thermal efficiency as compare to that of diesel.
- Mechanical efficiency of engine is increased by the blends of CWBD with diesel.
- CO2, CO, HC, NOX emissions of blends of CWBD with diesel are slightly varied with pure diesel.
- Use of CWBD will lead to better fuel economy and reduce fuel emission so it is best substitute for diesel in especially automotive industry.
- It reduces green house effect gases emissions and there by reduces the environmental impact of transportation.

On whole it is concluded that the blends of CWBD especially (10% CWBD + 90%Diesel) will be a best alternative fuel for automotive applications and agriculture application and will save much of our foreign currency exchange.

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