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"PERFORMANCE & EMISSION ANALYSIS OF SINGLE CYLINDER DIESEL ENGINE USING BIODIESEL BLENDS"

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Abstract - *Now a day the use of petrol and diesel-based products are increased to run the machines and engines. The biggest problem is to use petrol and diesel is that they have limited source and supply. To reduce this alternative fuel is used i.e. Bio fuels. Biodiesel are extracted from trans esterification process of edible and non- edible oil of vegetable and animal fat. It can be used in the diesel engine either in the form of neat oil or as a mixture of diesel fuel in the form of blend. The properties of oil are compared with the characteristic required for the fuel of internal combustion engine and the properties fuel are compared with conventional diesel fuel. The blends of biodiesel with small content in place of petroleum diesel can help in controlling air pollution and improving the performance without affecting on engine power and economy. This project consists of attention to acquiring knowledge of preparation of different blends of biodiesel (B00, B06, B12, B18, B24) using from Mexicana seeds, Mexicana seed with catalyst EHN, unused animal fat, animal fat with catalyst EHN, waste cooking oil and in this we assess engine testing with exhaust gas analysis to obtain best biodiesel blends results.*

Key Words: **Biodiesel, Transesterification process, Mexicana Blends, Waste Cooking Oil Blends, Chicken Fats Blends, EHN catalyst**

1.INTRODUCTION

In the 21st century, the climatic carbon dioxide level is 30% higher than the pre-mechanical period in 2011, the worldwide transport part having a 28% vitality offer and its represented just about a 1/fourth of the world's carbon dioxide discharges. Carbon dioxide is the real ozone harming substance adding to a dangerous atmospheric deviation and sea fermentation; henceforth, it is activating concern around the world.

Vitality request will even now increment significantly in the up and coming a very long time because of populace development and slow ascent in expectations for everyday comforts, particularly in creating nations. In this way, needs should twofold by 2050.

To fulfill this request, the vitality sources will turn out to be more correlative than aggressive. Hydrocarbons will assume a noteworthy part later on, especially in the vehicle and petrochemical areas. They will stay hard to substitute in the short and medium terms.

Biodiesel is an elective fuel like fossil diesel, being conceivable utilizing only it or in mixes with fossil diesel. It is easy to utilize, biodegradable, non-lethal and, as it is 2 basically free of sulfur and aromatics, permits a significative lessening of air emanations, in particular, of carbon mixes.

The aim of the present work was to study the esterification & transesterification with engine testing & exhaust gas analysis of below mentioned blends:

1. Chicken Fats Biodiesel
2. Chicken Fats Biodiesel with EHN additive
3. Mexicana seed Biodiesel
4. Mexicana seed Biodiesel with N-Butanol additive
5. Waste Fried Oil Biodiesel

1.1 BIODIESEL

Biodiesel is a fluid biofuel got by concoction forms from vegetable oils or creature fats and a liquor that can be utilized as a part of diesel motors, alone or mixed with diesel oil. ASTM International (initially known as the American Society for Testing and Materials) characterizes biodiesel as a blend of long-chain monoalkylic esters from unsaturated fats got from sustainable assets, to be utilized as a part of diesel motors. Mixes with diesel fuel are demonstrated as "Bx", where "x" is the level of biodiesel in the mix. For example, "B6" demonstrates a mix with 6% biodiesel and 94% diesel fuel; in outcome, B100 shows unadulterated biodiesel.

The crude materials for biodiesel creation are vegetable oils, creature fats and short chain alcohols. The oils most utilized for overall biodiesel creation are rapeseed (for the most part in the European Union nations), soybean (Argentina and the United States of America), palm (Asian and Central American nations) and sunflower, albeit different oils are likewise utilized, including nut, linseed, safflower, utilized vegetable oils, and furthermore creature fats. Methanol is the most oftentimes utilized liquor despite the fact that ethanol can likewise be utilized. Since cost is the primary worry in biodiesel creation and exchanging (primarily because of oil costs), the utilization of non-eatable vegetable oils has been considered for quite a long while with great outcomes.

In spite of the fact that the properties of oils and fats utilized as crude materials may contrast, the properties of biodiesel must be the same, consenting to the necessities set by universal principles.

1.2 LITERATURE REVIEW

R. S. Panua 2014:

Keeping in mind the end goal to meet the vitality prerequisites, there has been developing enthusiasm for elective fills like vegetable oils, biodiesels, biogas, LPG, CNG to give a reasonable diesel oil substitute for interior burning motor. Vegetable oils on account of their horticultural birthplace, because of less carbon content contrasted with mineral diesel are delivering less CO2 outflows to the environment. [1]

Kambiz Tahvildari a 2011:

As of late, in view of a quick increment of the cost of oil diesel biodiesel is most broadly acknowledged elective fuel because of natural favourable circumstances. Generation biodiesel from other reasonable feedstock may fundamentally decrease the cost of biodiesel [2].

Oner & Altun 2009:

Oner & Altun clarified transformation of creature fat into valuable biodiesel by transesterification process and researched execution and discharge attributes of an immediate infusion diesel motor. From their investigation it was inferred that creature fat methyl esters and its mixes with diesel fuel can be utilized as a substitute for diesel in coordinate infusion diesel motors with no motor change [3].

Manzanera et al 2008:

By 1920, the fast improvement of the oil business soon made petro diesel a less expensive and quality contrasting option to vegetable oil. [4]

Seung Hyun Yoon 2008:

Bio diesel powers got from vegetable oils or creature fats and which are utilized as substitutes for customary oil fuel in diesel motors have as of late gotten expanded consideration. This intrigue depends on various properties of bio diesel including its biodegradability and the way that it is created from a sustainable asset. These highlights of bio diesel prompt its most noteworthy favorable position, which is its potential for emanation diminishment. [5]

Senthi Kumar 2005:

Senthil Kumar et al (2005) researched preheating of creature fat at five unique temperatures and tried it as a fuel in CI motor. In their examination, creature fat is preheated to 30°C, 40°C, 50°C, 60°C and 70°C preceding it is infused into ignition assembly of a motor. The outcomes demonstrated that preheated creature fat lessens start postponement and burning term though most extreme ignition weight and rate of weight ascend are high with creature fat at high fuel bay temperatures. [6]

Wyatt al 2005:

Wyatt et al (2005) broke down biodiesel creation and properties of grease, meat fat and chicken fat by base-catalysed transesterification. Nitrogen oxide (NOx) outflow tests were led in a Yammer L100 single barrel coordinate infusion diesel motor utilizing creature fat-determined esters and soybean oil biodiesel as 20% by volume (B20 mix) with diesel. The outcomes showed that the three-creature fat-based B20 energizes had bring down NOx emanation levels (3.2– 6.2%) than did the soy oil-based B20 fuel. [7]

1.3 PROBLEM STATEMENT: -

- Biodiesel has been accepted worldwide as an immediate solution to the heavy dependence on diesel fuel. However, the prolonged reliance on edible oils as feedstock for biodiesel production has threatened the supply of edible oil to food industry and raised some environmental problems such as serious destruction of vital soil resources, deforestation and usage of much of the available arable land.
- Moreover, in the last ten years the prices of vegetable oil plants have increased dramatically which will affect the economic viability of biodiesel industry.
- Due to these factors, it is crucial to find other alternative oil feedstock to substitute edible oil in the production of biodiesel.

Therefore, the main objective of this study is synthesizing biodiesel from chicken fat, waste fried oil, Mexicana seeds oil and compare with pure diesel.

2. OBJECTIVES

- Identification of environmentally friendly and renewable sources as alternative for petro diesel.
- This project aims to improve the energy balance, the carbon performance, the sustainability and the overall economics of biodiesel production, and to reduce the sensitivity of biodiesel plant economics to volatile methanol and glycerin spot prices.
- Preparation of blends of biodiesel with diesel fuel like (B00, B06, B12, B18, B30, B36)
- Quality testing of all biodiesel blend along with diesel fuel e.g. density, viscosity, flash point, fire point, cetane number etc.

- Extraction of oil by different process.
- To perform engine analysis and exhaust analysis. (Brake Power, Brake Thermal Efficiency, Indicated Power, Brake Specific Fuel Consumption, Braking Torque).
- Combustion analysis-preparation of heat balance sheet.

Search of best blends for diesel fuel without modification in diesel engine

3. METHODOLOGY

The project is divided into 6 phases viz. Esterification, Transesterification, Settling, Separation, Washing and drying of the biodiesel & Addition of additives. Esterification and Transesterification are the process which deals with the extraction of oil. Settling represents the time requires for oil to settle. Separation deals with separating oil from the impurities. Washing and drying is done to wash out the small impurities. Addition of additives to the obtained biodiesel in order to increase its efficiency. The main aim of the project is to increase the use of biodiesel since diesel is nonrenewable resource.

3.1 Methodology for biodiesel based on chicken fat blend without & with EHN

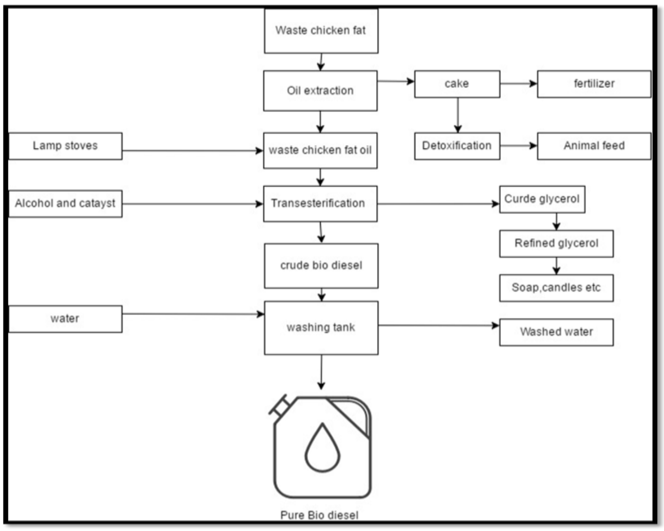


Fig 3.1.1: Flow Chart of Biodiesel Production

ESTERIFICATION

Materials and apparatus

1. Thermometer
2. Electric weighing balance
3. Water bath with shaker
4. Beakers, flasks, stirrer, syringe
5. Separating funnel
6. Flash point tester
7. Cloud and pour point bath
8. Viscometer bath and stove
9. Reagents: sulfuric acid, methanol, potassium hydroxide, distilled water, phenolphthalein and chicken fat

PROCEDURE

Fig 3.1.2: Round Bottom Flask Apparatus

The chicken fat was bought from poultry. It was then taken to the Laboratory. The free fatty acid (FFA) of the chicken fat was determined and found to be 4.16%. This value must be treated to reduce it to ≤ 3% before the transesterification. The chicken fat was dissolved using a stirrer at 60˚C for 30 minutes after which it was cooled for another 30 minutes. The mixture was inserted into a water bath with a regulated temperature of 60˚C and a speed of 300 rpm and timed for 1 hour 20 minutes. At the end of the pre-treatment, the mixture was poured into a separating funnel and left there to settle overnight. Three layers were observed; the upper layer is the methanol, the middle layer is the water and the underneath layer is the chicken fat.

3.2 Methodology for biodiesel based on Mexicana seeds blend with & without EHN

Procedure of extraction of biodiesel

Seeds collection

Fig 3.2.1: Mexicana seed plant

Fig 3.2.2: Seeds collected from Mexicana plant

Drying of seeds

Fig 3.2.3: Dried seeds of Mexicana

Crushing of seeds

Fig 3.2.4: Crushed Mexicana seeds

Extraction of oil:

Prior to the extraction process Mexicana seeds were dried at 50 C for 12 hours in the oven to remove the excess moisture. The dried seeds were then weighed and powdered. The fine seed powder was then subjected to Soxhlet apparatus using methanol as a solvent. The duration of each batch was 10 hours for complete extraction. The solvent required for extraction of per kg seeds was in the ratio of 5:1 (5L solvent for 1kg seeds). The oil was recovered from the solvent by distillation process. The extracted oil was then measured to calculate the percentage oil in the seeds.

Fig 3.2.5: Extraction of Oil using Soxhalt Apparatus.

3.3 Methodology for biodiesel based on Waste Fried Oil

Vegetable oil and its methyl esters are the prominent candidates for alternative diesel fuels. These fuels are now under its initial stage of commercialization they are technically feasible and economically competitive as compared with convectional diesel fuel.

Used cooking oils/waste cooking oils/waste frying oil and fat residues from meat processing may be used as raw materials which are obtained after repetitive frying of the food products. Previously the waste vegetable oil was used as an ingredient in animal feed but, it was banned by European Union due to animal health hazards. The disposal of waste cooking oil is a problem since, it contaminates water resource and blocks the drainage systems. So, using it as an alternative fuel is therefore found most suitable solution not only for disposal but also to manage the fuel crisis. In Some instances, the waste cooking oils are used to manufacture soaps and detergents but a major volume of waste cooking oil is discharged to environment.

Preparation of blends of biodiesel

1. Filtration-

Filtration is basically used for removing solid impurities in used cooking fried oil. Collected used fried oil is passed through oil filtration unit. One liter used fried oil is taken in beaker for further activities.

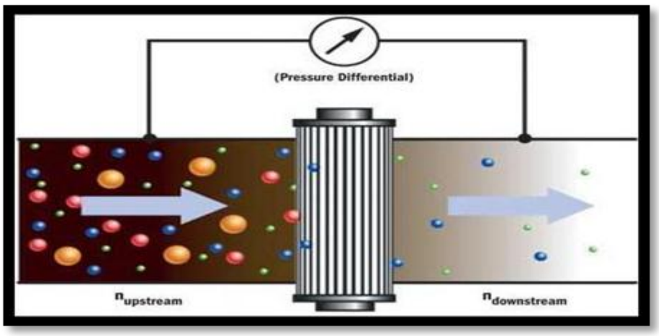


Fig.3.3.1: filtration unit

2. Demoisturization-

Demoisturization is used for removing moisture contain in oil. Filtrated oil is heated up to 110°C. Hence water having 100°C boiling point is evaporated. By this process we get demoisturized fried oil.

Fig.3.3.2: Demoisturization setup

Further steps are common for all blends:

ESTERIFICATION

This is process used to reduce acid value of the oil. In this process there are following steps:

- First the oil is preheated to 40°C.
- Then 0.5to0.7% (5to7gm per liter) of H_2SO_4 is added.
- After 2 min nearly 13% (130gm per liter) of methyl/ethyl alcohol is added.
- And temperature is maintained constant about 55° to 65°C for about 45 to 50 min.

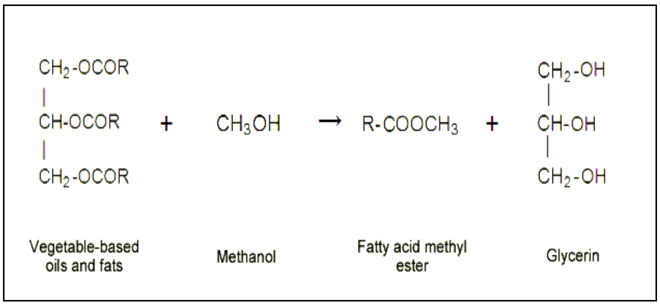


Fig 3.2.3: Esterification process

TRANS-ESTERIFICATION

1.5% (15gm per liter) of aluminum oxide will be added to 130 ml of Methyl alcohol. Then this mixture will be added in unit called trans-esterification unit. Again, temperature will be maintained at 55° to 60° C for about 1hr30.

Fig 3.2.4: Trans-esterification Process set up

SETTLING AND SEPARATION

In this process glycerin and alcohol mixture is settled at various levels. For this settling apparatus is used. The mixture in apparatus is kept overnight. Another day separate layers of glycerin oil and alcohol mixture and unreacted Alcohol is obtained. The layers obtained in settling will be removed one by one separately.

Fig 3.2.5: Before & after image of Biodiesel in settling apparatus

DISTILLATION

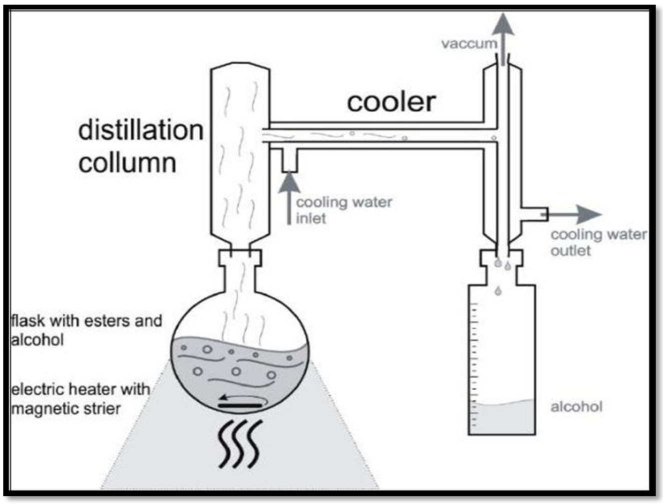


Fig 3.3.6: Distillation process

Distillation process is used for alcohol separation.

After removing glycerin and unreacted alcohol layer, Biodiesel+Alcohol solution is taken out in round bottom flask.

It is placed in water bath and distillation tube is placed on upper side of round bottom flask. Water bath coils are heated up to 90°C.where boiling point of alcohol is less than 90°C.Hence, alcohol start to evaporate. Slowly-slowly in distillation tube, after 1-hour alcohol droplets get collected in another beaker which alcohol can be reused. By this process distillation is carried out.

WASHING

Fig.3.3.7: Washing Unit

The useless retainment's of above reactions will be separated by washing. In washing we used distilled water (warm water which cooled for several time). Distilled water is added to oil mixture in settling apparatus. The mixture is kept still to settle for 5 min and then two layers obtained of which upper is biodiesel oil and at bottom unwanted white waste solution which is removed from bottom slowly. This Washing process is repeated for 4 to 5 times. Here we get biodiesel solution of neutral pH value (i.e. 6.5 to7)

After that we carried out demoisturizing process and water will be removed by heating 3 to 4 times until constant mass of oil is obtained. This obtain oil is our pure biodiesel which is B100.

BLENDS PREPARATION

Diesel and oil were mixed in required proportion and then constantly heated at 40°C to 45°C for 20 min unless two layers form homogenous mixture.

Blends prepared was B00, B06, B12, B18, B24, B30 and B36.

Actual Photographs of Chicken Fat Biodiesel Blends with EHN

Actual Photographs of Chicken Fat Biodiesel

Mexicana Seed Blends

Mexicana Seed Blends with N-Butanol

Actual Photographs of Waste Fried Oil

Fig.3.3.8: Actual Blends Photographs

3.4 Determination of Properties of The Biodiesel

Estimation of the following properties of the produced biodiesel is discussed as below:

Density – Mass / Volume

Calorific value - The calorific value can be determined using the heat balance. Heat given by the fuel is equal to the heat gained by the water

Viscosity - Redwood viscometer

Moisture – Removed by heating

Flash point - Abel´s Flash Point Apparatus

Fire point - Abel´s Flash Point Apparatus

Cloud point - the Cloud and Pour point apparatus

Pour point. - the Cloud and Pour point apparatus

Ash content - electric muffle furnace of Wiswo

1.Chicken Fat Biodiesel Blends

Table no.: 3.4.1

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	Chicken fat oil biodiesel blends					
			Unit	Limit	B00%	B6%	B12%	B18%	B24%	B30%	B36%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.833	0.384	0.836	0.838	0.841	0.844
2	Calorific value	D6751	MJ/Kg	34-45	42.50	42.41	42.20	42.09	41.96	41.86	41.55
3	Cetane no.	D613	-	41-55	49.00	49.44	49.70	49.88	49.95	50.11	50.26
4	Viscosity	D445	mm2/sec	3--6	2.700	-	-		2.96	-	
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	°C	-	64	75.00	89.00	96.00	102.00	110.00	117.00
7	Fire point	D93	°C	-	71	-	-	-	111.0	-	-
8	Cloud point	D2500	°C	-	-4	-	-	-	3.0	-	-
9	Pour pont	D2500	°C		-9	-	-	-	-1.0	-	-
10	Ash	D	%	-	0.05	-	-	-	0.1	-	-

2.Chicken Fat with EHN Biodiesel Blends

Table no.: 3.4.2

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	Chicken fat oil biodiesel blends					
			Unit	Limit	B00%	B6%	B12%	B18%	B24%	B30%	B36%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.833	0.384	0.836	0.838	0.841	0.844
2	Calorific value	D6751	MJ/Kg	34-45	42.50	42.41	42.20	42.09	41.96	41.86	41.55
3	Cetane no.	D613	-	41-55	49.00	49.44	49.70	49.88	49.95	50.11	50.26
4	Viscosity	D445	mm2/sec	3--6	2.700	-	-		2.96	-	
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	°C	-	64	75.00	89.00	96.00	102.00	110.00	117.00
7	Fire point	D93	°C	-	71	-	-	-	111.0	-	-
8	Cloud point	D2500	°C	-	-4	-	-	-	3.0	-	-
9	Pour pont	D2500	°C		-9	-	-	-	-1.0	-	-
10	Ash	D	%	-	0.05	-	-	-	0.1	-	-

3. Mexicana Seeds Biodiesel Blends:

Table no.: 3.4.2

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	Mexicana biodiesel blends					
			Unit	Limit	B00%	B9%	B18%	B27%	B36%	B45%	B54%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.833	0.836	0.838	0.840	0.841	0.843
2	Calorific value	D6751	MJ/Kg	34-45	42.50	42.44	42.31	42.18	42.05	41.93	41.79
3	Cetane no.	D613	-	41-55	49.00	49.36	49.59	49.72	49.86	49.99	50.22
4	Viscosity	D445	mm2/sec	3--6	2.700	-	-	2.96	-	-	-
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	°C	-	64.0	76.00	84.00	98.00	109.00	117.00	122.00
7	Fire point	D93	°C	-	71.0	-	-	107.00	-	-	-
8	Cloud point	D2500	°C	-	-4.0	-	-	3.50	-	-	-
9	Pour pont	D2500	°C		-9.0	-	-	-1.00	-	-	-
10	Ash	D	%	-	0.05	-	-	0.05	-	-	-

4.Mexicana Seeds Biodiesel Blends with +5% n butanol:

Table no.: 3.5.3

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	Mexicana biodiesel blends + 5% n- butanol					
			Unit	Limit	B00%	B9%	B18%	B27%	B36%	B45%	B54%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.832	0.833	0.834	0.835	0.838	0.840
2	Calorific value	D6751	MJ/Kg	34-45	42.50	42.40	42.26	42.06	41.90	41.88	41.76
3	Cetane no.	D613	-	41-55	49.00	49.22	49.48	49.60	49.79	49.90	50.02
4	Viscosity	D445	mm2/sec	3--6	2.700	-	-	2.81	-	-	-
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	°C	-	64	67.00	70.000	76.00	80.0	87.000	92.000
7	Fire point	D93	°C	-	71	-	-	92.00	-	-	-
8	Cloud point	D2500	°C	-	-4	-	-	2.000	-	-	-
9	Pour pont	D2500	°C		-9	-	-	-1.000	-	-	-
10	Ash	D	%	-	0.05	-	-	0.050	-	-	-

5.Waste Fried Oil Blends:

Table no.: 3.5.4

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	WCO biodiesel and blends					
			Unit	Limit	B00%	B6%	B12%	B18%	B24%	B30%	B36%
1	Density	D1448	*gm/cc*	0.800-0.900	0.830	0.831	0.833	0.834	0.836	0.837	0.839
2	Calorific value	D6751	*MJ/Kg*	34-45	42.50	42.39	42.28	42.11	41.90	41.78	41.55
4	Viscoisity	D445	*mm2/sec*	3--6	2.700	-	-	-	2.96	-	-
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA
6	Flash point	D93	^oC	-	64	68.000	72.000	79.000	85.0	94.000	105.000
7	Fire point	D93	^oC	-	71	-	-	-	96.0	-	-
8	Cloud point	D2500	^oC	-	-4	-	-	-	2.5	-	-
9	Pour pont	D2500	^oC		-9	-	-	-	-1.0	-	-
10	Ash	D	%	-	0.05	-	-	-	0.1	-	-

3.5 VCR TESTING

Fig.3.5.1: Kirloskar VCR Engine

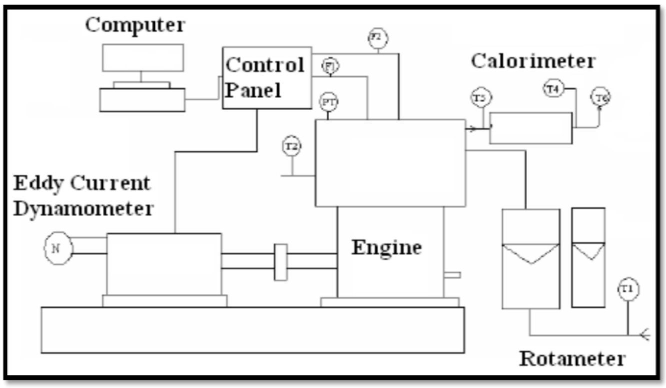


Fig.3.5.2: Engine Setup

Specification of the engine

Type : Kirloskar TV1 VCR engine

Cylinder : Single, vertical, water cooled

Stroke : Four

Fuel used : Diesel

Speed : 1500 rpm

Power : 3.5 HP

Bore : 87.5 mm

Stroke : 110 mm

Loading device: Eddy current Dynamometer

Software used: National instruments & engine of LV. Engine performance Analysis software.

Test was taken on VCR engine by using petroleum diesel and blending with biodiesel & results are shown below.

4. COMBUSTION ANALYSIS

4.1.1 Combustion Analysis of Chicken Fat Biodiesel Blends

Table No.: 4.1.1

Blends	Load(kg)	CO %	CO2 %	O2 %
B00	0.3	0.024	0.5	20.04
	3	0.027	0.9	19.68
	6	0.016	1.2	19.15
	9	0.015	1.6	18.51
	12	0.016	1.9	18.03
B06	0.3	0.046	0.98	19.45
	3	0.043	1.2	20.91
	6	0.042	1.5	18.6
	9	0.036	1.8	18.14
	12	0.031	2.2	17.62
B12	0.3	0.039	0.6	19.99
	3	0.038	1	19.62
	6	0.026	1.3	19.08
	9	0.03	1.7	18.49
	12	0.033	2.2	17.75
B18	0.3	0.036	1	19.46
	3	0.026	1.4	18.95
	6	0.021	1.7	18.37
	9	0.02	2.09	17.65
	12	0.02	2.2	17.6
B30	0.3	0.032	0.6	19.93
	3	0.036	1	19.5
	6	0.021	1.5	19
	9	0.026	1.7	18
	12	0.028	2.09	17.74

4.1.2 Combustion Analysis of Chicken Fat Biodiesel Blends with EHN

Table No.: 4.1.2

Blends	Load(in kg)	CO %	CO2 %	O2 %
B00	0.3	0.024	0.5	20.04
	3	0.027	0.9	19.68
	6	0.016	1.2	19.15
	9	0.015	1.6	18.51
B06	0.3	0.085	1.4	18.5
	3	0.074	1.9	17.67
	6	0.061	2.7	16.51
	9	0.063	3.6	15.32
B12	0.3	0.088	1.4	18.66
	3	0.105	1.9	17.83
	6	0.052	2.6	16.77
	9	0.055	3.6	15.49
B18	0.3	0.073	1.3	18.83
	3	0.08	1.9	12.98
	6	0.052	2.6	16.83
	9	0.051	3.5	15.58
B24	0.3	0.075	1.9	18.02
	3	0.075	1.9	18.02
	6	0.05	2.7	16.85
	9	0.053	3.7	15.38

4.1.3 Combustion Analysis of Mexicana Biodiesel Blends

Table No.: 4.1.3

Blends	Load(kg)	CO %	CO_2 %	O_2%
B00	0.3	0.024	0.5	20.04
	3	0.027	0.9	19.68
	6	0.016	1.2	19.15
	9	0.015	1.6	18.51
	12	0.016	1.9	18.03
B09	0.3	0.044	0.4	19.95
	3	0.052	0.8	19.52
	6	0.038	1.1	19.03
	9	0.028	1.5	18.37
	12	0.035	1.9	17.87
B18	0.3	0.031	0.5	20.06
	3	0.039	0.9	19.61
	6	0.026	1.2	19.11
	9	0.034	1.7	18.45
	12	0.032	2	17.98
B27	0.3	0.033	0.5	20.08
	3	0.041	0.9	19.65
	6	0.044	1.3	18.99
	9	0.036	1.5	18.46
	12	0.039	2	17.89
B36	0.3	0.038	0.5	20.03
	3	0.052	0.9	19.56
	6	0.034	1.2	19.09
	9	0.025	1.6	18.6
	12	0.031	2	17.81

4.1.4 Combustion Analysis of Mexicana Biodiesel Blends with n-Butanol

Table No.: 4.1.4

Blends	Load(kg)	CO %	CO2 %	O2 %
B00	0.3	0.024	0.5	20.04
	3	0.027	0.9	19.68
	6	0.016	1.2	19.15
	9	0.015	1.6	18.51
	12	0.016	1.9	18.03
B06	0.3	0.04	0.4	20.08
	3	0.045	0.8	19.62
	6	0.023	1.1	19.12
	9	0.023	1.5	18.51
	12	0.042	1.9	17.78
B12	0.3	0.042	0.5	19.95
	3	0.043	0.9	19.52
	6	0.033	1.2	19.16
	9	0.031	1.7	18.32
	12	0.032	2	17.82
B18	0.3	0.035	0.5	20.14
	3	0.043	0.9	19.62
	6	0.034	1.3	19.03
	9	0.025	1.5	18.68
	12	0.036	2	17.83
B24	0.3	0.038	0.5	20.1
	3	0.048	0.9	19.62
	6	0.037	1.2	19.15
	9	0.038	1.6	18.54

4.1.5 Combustion Analysis of Waste Fried Oil Biodiesel Blends

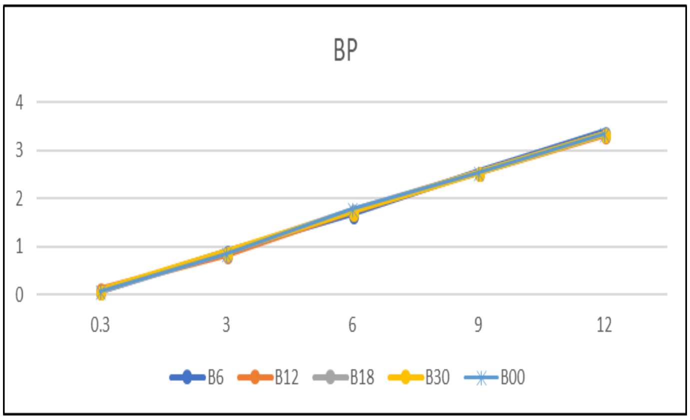
Table No.: 4.1.5

Blends	Load(in kg)	CO %	CO2 %	O2 %
B00	0.3	0.024	0.5	20.04
	3	0.027	0.9	19.68
	6	0.016	1.2	19.15
	9	0.015	1.6	18.51
	12	0.016	1.9	18.03
B06	0.3	0.038	0.6	20.11
	3	0.042	0.8	19.75
	6	0.047	1.2	19
	9	0.047	1.6	18.46
	12	0.039	1.9	17.95
B12	0.3	0.023	0.4	20.29
	3	0.014	0.3	20.46
	6	0.015	0.3	19.7
	9	0.026	1.1	19.26
	12	0.023	1.4	18.81
B18	0.3	0.037	0.6	20.01
	3	0.039	0.3	19.79
	6	0.025	1.1	19.31
	9	0.024	1.3	13.99
	12	0.032	1.7	18.33
B24	0.3	0.022	0.3	20.36
	3	0.026	0.6	20.04
	6	0.031	1.3	18.99
	9	0.032	1.7	13.37
	12	0.038	2	17.87

4.2 PERFORMANCE ANALYSIS

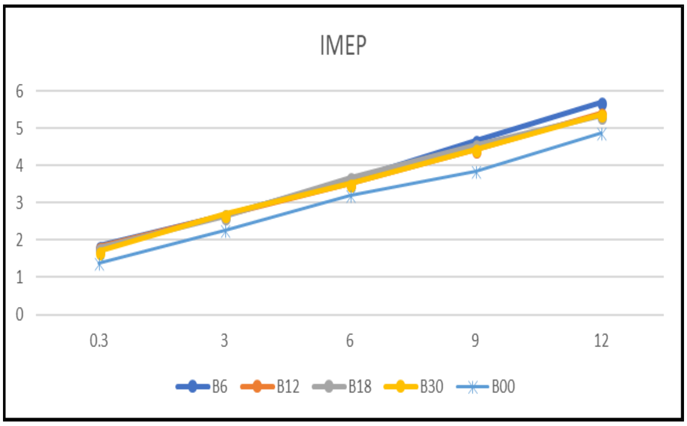
4.2.1 Performance Analysis of Chicken Fat Biodiesel Blends

Brake Power V/S Load (Kg)



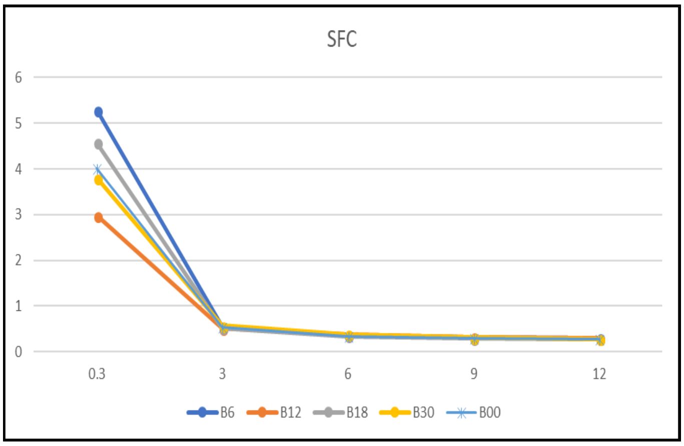
Graph No.:4.2.1

Indicated Mean Effected Pressure V/S Load



Graph No.: 4.2.2

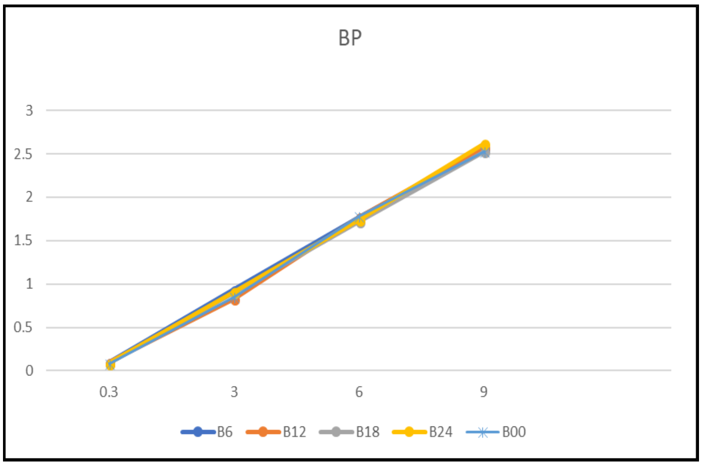
Brake Specification Fuel Consumption V/S Load (Kg):



Graph No.:4.2.3

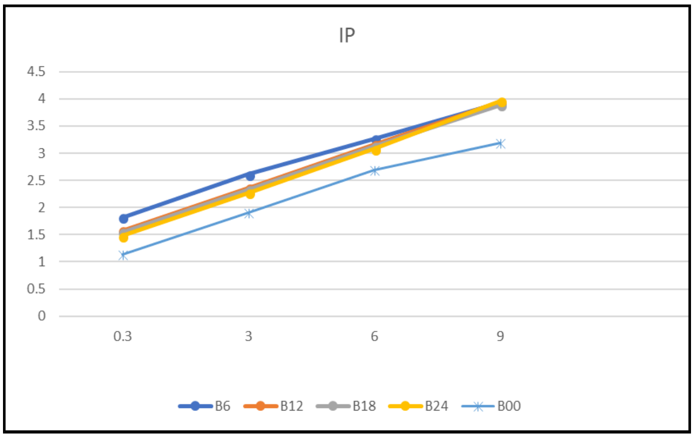
4.2.2 Performance Analysis of Chicken Fat Biodiesel Blends With EHN As A Additives

Brake Power V/S Load (Kg)



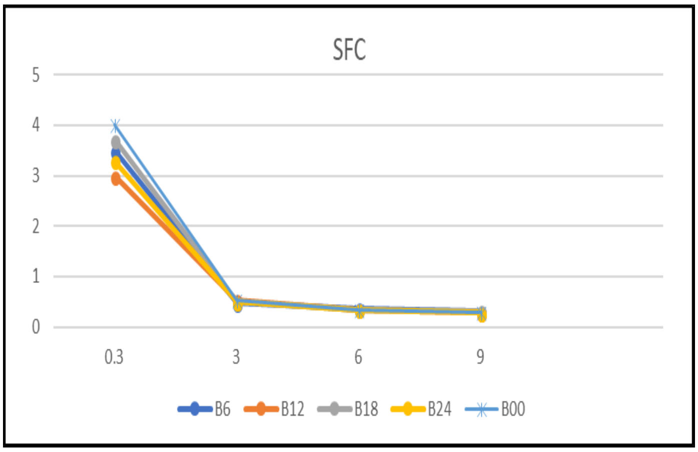
Graph No.: 4.2.4

Indicated Power V/S Load (Kg)



Graph No.: 4.2.5

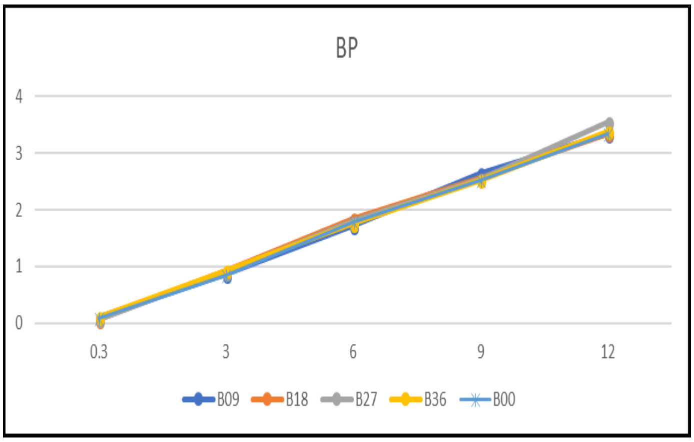
Specific Fuel Consumption V/S Load (Kg)



Graph No.: 4.2.6

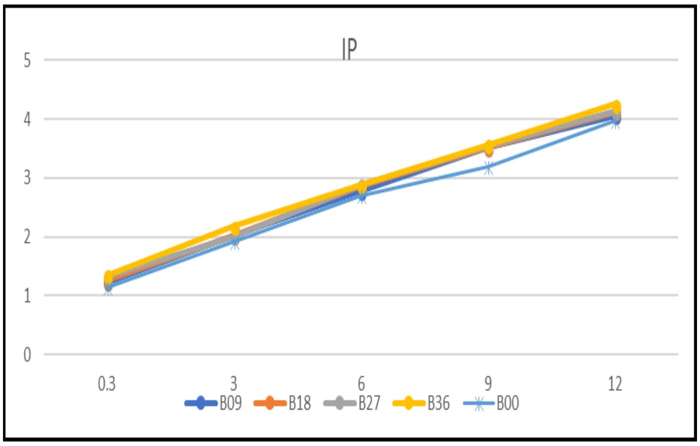
4.2.3 Performance Analysis of Mexicana Biodiesel Blends

Brake Power V/S Load (Kg)



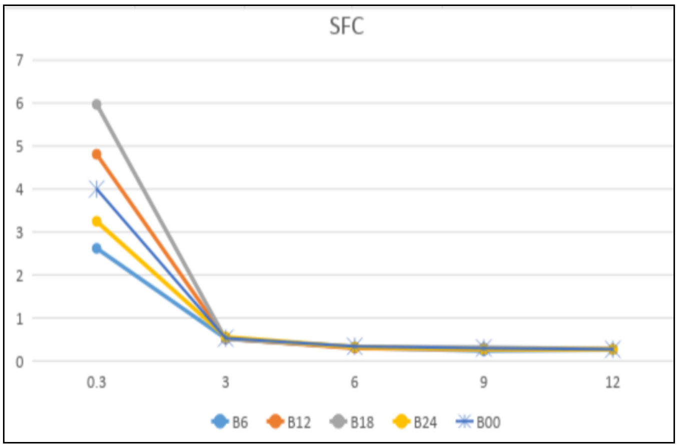
Graph No.: 4.2.7

Indicated Power (Kw) V/S Load (Kg)



Graph No.: 4.2.8

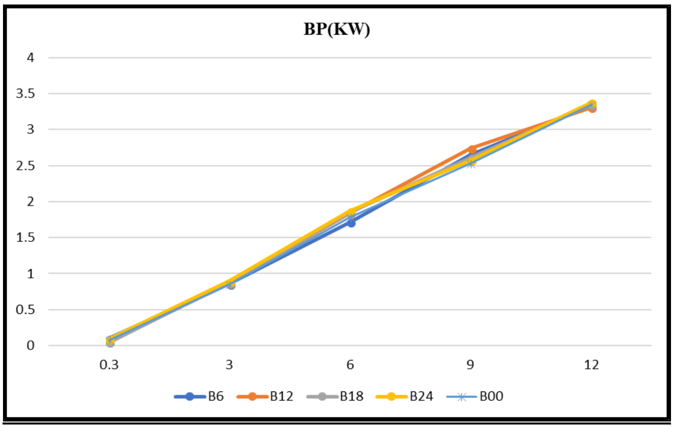
Bsfc (Kg/Kwhr) V/S Load (Kg)



Graph No.: 4.2.9

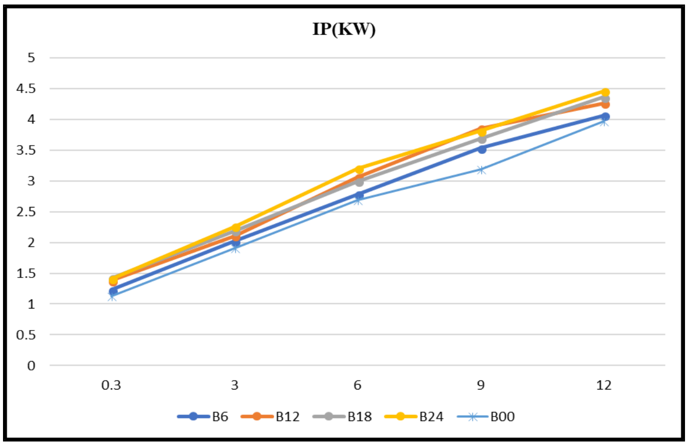
4.2.4 Performance Analysis Of Mexicana Biodiesel Blends With N-Butanol As Additives

Brake Power (Kw) V/S Load (Kg)



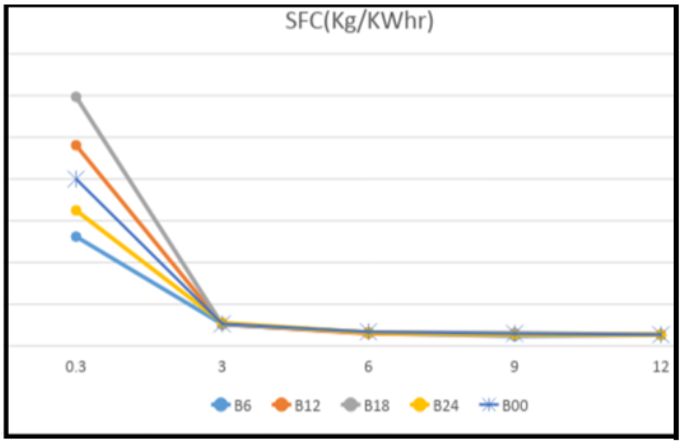
Graph No.: 4.2.10

Indicated Power (Kw) V/S Load (Kg)



Graph No.: 4.2.11

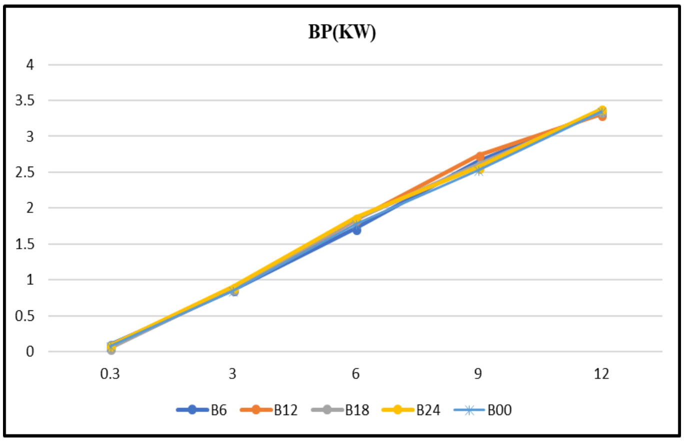
Bsfc V/S Load (Kg)



Graph No.: 4.2.12

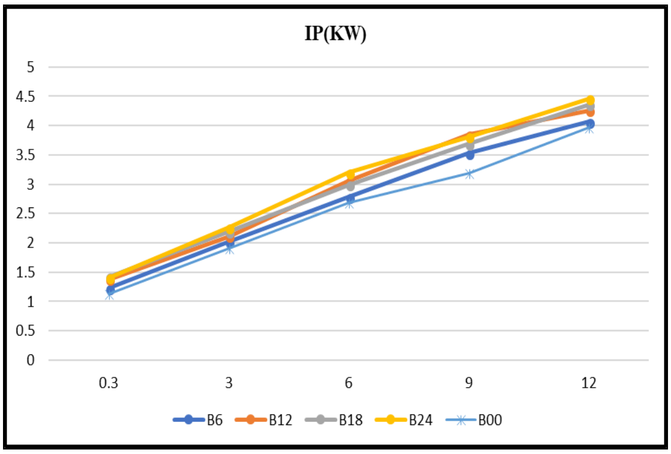
4.2.5 PERFORMANCE ANALYSIS OF WASTE FRIED OIL BIODIESEL BLENDS

Brake Power (Kw) V/S Load (Kg)



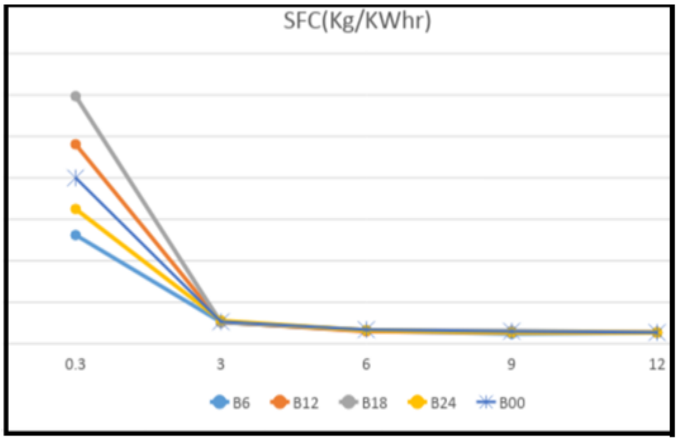
Graph No.:4.2.13

Indicated Power (Kw) V/S Load (Kg)



Graph No.:4.2.14

Bsfc V/S Load (Kg)



Graph No.:4.2.23

4.3 Cost Estimation

Table No.:4.3

Sr No.	Procedure	Cost (In Rupees)
1	Indian Biodiesel Corporation Registration Fees	3,600/-
2	Blend Preparation Charges (30 blends)	15,000/-
3	Engine Testing	4,000/-
4	Travelling and Stationary	4,000/-
	Total cost of project	**26,600/-**

5.CONCLUSION

In this project various type of blends from Chicken fat with and without EHN, Mexicana seed oil with & without N Butanol, Waste fried oil are made and their performance characteristic on IC Engine are tested to compare the result between all different types of blends. Finally, we have decided which blends are effective in economy as well as safe from environment point of view. This will also lead to reduce pollution as compared to Petroleum diesel.

Table No.:5.1

BIODIESEL	BLEND	CO%	CO2%	O2%	BP(KW)	MECH EFF.	BSFC (Kg/KwHr)
Pure Diesel	B00	0.016	1.9	18.03	3.35	84.47	0.27
Chicken Fat	B18	0.02	2.2	17.75	3.35	76.87	0.28
Chicken Fat with EHN	B18	0.051	3.5	15.58	2.53	64.95	0.32
Mexicana	B36	0.031	2	17.81	3.38	75.87	0.27
Mexicana + N Butanol	B12	0.032	2	17.82	3.35	82.73	0.25
Waste Fried Oil	B12	0.023	1.4	18.81	3.31	77.77	0.27

From above analysis, waste fried oil's B12 blend and chicken fat's B18 blend are showing their performance very close to pure diesel B00.

Other blends are also showing same BP, Mechanical efficiency, BSFC result but their CO% emissions are very high. It will increase pollution instead of reducing it.

Finally, we have come to the conclusion that out of these 5 different types of biodiesel & their 30 blends;

Waste Fried oil's B12 & Chicken fat oil' B18 are most effective in economy as well as safe from environment point of view comparatively with pure diesel.

5.1 FUTURE SCOPE

In this analysis, we have done production of chicken fat, Mexicana seed oil, waste cooking oil-based biodiesel with and without addition of additives. We have also compared chemical properties analysis and exhaust gas analysis of blends of bio-diesel with petroleum diesel. Testing of bio-diesel blends carried on computerized single cylinder V.C.R. diesel engine at constant speed, variable loading conditions and check the effect performance characteristics of diesel engine, satisfactory result are achieved, hence taking encouragement from this;

Future work can be carried out as follows:

- Dissertation work analysis is carried out by considering the heterogeneous catalyst on production, in near future this analysis carried out for other heterogeneous catalyst.
- We can also check the effect of other additives on properties of bio-diesel blends.
- The scope for optimization, design and fabrication of mass production system is available for future work.
- Scope is also there for to check performance characteristics of diesel engine by variable speed and constant load method.

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